Read Wonder Drugs in Farming

CHEMISTRY

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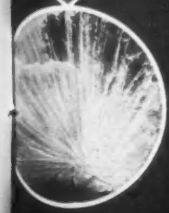

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How Liberal Your Education?
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50¢

Thirty-seventh Year

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How Liberal Your Education?

FOR THE STUDENT planning a college course the question is not "What course should I take?" but rather "What kind of an education do I want?" His problem is one of communication with the people with whom he wants to work.

Technologic information has just hit the man-in-the-street, and he is rebelling against learning unfamiliar vocabularies. Pressure is brought to return to "the good old days" when everybody knew what education meant. About two generations ago this meant the ability to read Latin and Greek, because of the idea that all the really great literature had been written in those languages. A long struggle was necessary before scholars would admit that anything worth reading had been written in a modern tongue.

A similar protest is taking place against the language of science. Admitting that much written in this new language cannot be found elsewhere, the illiterate in it try to minimize its importance by claiming that those who speak it cannot talk to run-of-the-mill human beings. They advocate watered-down college courses with all the big words left out.

The choice here is the same as that of reading in translation or in the original language. For the person who does not know the language but wants the gist of the subject the translation is necessary. But the student who wants to communicate directly with the scientists in his chosen field will do well to learn the language in which scientists record their observations. That language is precise where a translation must always be slightly blurred.

Because the student has learned the language of science he need no more be limited by it than the Latin scholar. He has gained, not lost, in the ability to communicate with his fellow men. Science is a cultural subject, quite as much as any of the arts. In fact, much art is the empirical forerunner of science. Laws of optics and perspective were worked out by the great painters of the Renaissance. Novelists of the 19th century foreshadowed Freud. Music can use wave mechanics formulas. Thus the scientist gains double enjoyment. Even idle pastimes fit into his cultural pattern, for the enormously important laws of chance by which he is exploring the atom are the same laws that govern the fall of the dice, the runs of cards, the carom of a billiard ball. Let the science student point out the richness of his world to his timid colleagues.

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▶ THESE PIGS *are on a low protein diet with antibiotic added to the ration. Antibiotics are revolutionizing agriculture now as they did medicine. Growth stimulants for animals are big business. This is one of many tests of antibiotic feeding now in progress at the Beltsville, Md., Experiment Station of the U. S. Department of Agriculture.*

Wonder Drugs Change Farming

by CLARE COTTON

▶ THE ANTIBIOTIC wonder drugs, penicillin, streptomycin, Terramycin, Aureomycin and others, are familiar to most people as revolutionary developments in human medicine. Some scientists predict that the drugs will be even more revolutionary in agricultural uses.

As growth stimulants, antibiotics are widely used in animal feeds. It is estimated that 13% of the total 1952 antibiotic production, by weight, was fed to animals to promote speedier growth.

Experiments are continuing in federal, state and private research laboratories to test the use of antibiotics in animal feeds. Experts predict an expanding use of the drugs in animal diets.

The use of the wonder drugs to control bacterial plant diseases is the latest of the agricultural uses. Halo blight of beans and fireblight of apple and pear trees will be conquered by antibiotic sprays if extensive field tests bear out earlier results.

Fireblight is considered the worst single disease of fruit trees. In some

areas it has eliminated pear growing and seriously limited the varieties of applies that may be grown.

Research on fireblight control with antibiotics has been successful in widely separated centers. Dr. Robert Goodman of the University of Missouri, Dr. P. A. Ark of the University of California Experiment Station, and the Ohio Agricultural Experiment Station have reported success in using streptomycin and Terramycin against fireblight in apples.

Dr. J. C. Dunegan of the U. S. Department of Agriculture was also successful in controlling fireblight of pear trees in a small scale field experiment in California.

Chas. Pfizer and Sons, a large antibiotic manufacturing firm, has announced that Agrimycin, a commercial mixture of streptomycin and Terramycin, will be distributed in 1954 to test its power over fireblight on at least 100,000 apple and pear trees.

Work with halo blight of beans has centered at the Beltsville, Md., station of the Department of Agriculture. There Drs. John W. Mitchell and William J. Zaumeyer have found that streptomycin spray will control the disease.

This is a serious bean disease in Maryland, Florida, Michigan, Montana, South Dakota, Colorado, Nebraska, Oregon, Wyoming, West Virginia and New York.

Among the important results of this research is evidence that streptomycin acts systemically in bean plants. This means the antibiotic gets into the plant's circulation system and is carried to the point of infection.

Use of antibiotics against common blight of beans, a tougher disease, has not yet been successful, Dr. Mitchell said.

The future use of antibiotics against plant diseases is limited to bacterial diseases. Unfortunately, other serious plant diseases are caused by virus and fungus infection. Any reduction in the nation's annual loss to plant diseases, however, will be welcomed by farmers.

Much more debatable is the future of antibiotics in food preservation. In addition to research problems in this field, the Food and Drug Administration of the federal government has taken a stand against the addition of antibiotics to foods which are to be eaten by humans.

There is no evidence that the Food and Drug Administration will change this stand until definite proof has been given that food preservation with antibiotics does not harm consumers.

Research, however, is continuing. Dr. Wilson L. Smith at the Beltsville station has established that a spray of one-tenth of one per cent of streptomycin will increase the shelf life of packaged spinach by at least one day.

Rot decay of packaged green vegetables is an important economic problem. The rotting is caused by bacteria.

The use of antibiotics in long-term food preservation is also the object of much research. Here efforts center on completely killing a bacteria genus called Clostridia which produces extremely dangerous poisons. The best known of these is Clostridia botulinum which causes botulism in humans.

These organisms thrive in the absence of air. Sealed tin cans provide the ideal environment for their development. Extremely high temperatures are used in commercial food processing to kill these organisms.

Some reports of success and failure have been given in this field. One complicating factor is the heat-resistant spore form produced by the bacteria. These spore forms may also be resistant to the antibiotics.

Application of antibiotics to this field appears to be somewhat distant awaiting the solution of difficult research problems and establishment of public health safeguards.

The best known of the non-medical uses of antibiotics is in animal feed. In 1950 reports began to appear indicating that antibiotics could stimulate the growth of animals. In the few years since then the addition of antibiotics to animal feeds has become a big business.

The exact manner in which the drugs stimulate growth is under intensive investigation in many university and experiment station laboratories. Most authorities agree that antibiotics stimulate growth by suppressing harmful bacteria in the intestines or by aiding the animal in the use of its food.

Much concentrated study is now being devoted to the problem of stimulating plant growth with antibiotics. Dr. Mitchell has found that some plants are extremely sensitive to even small quantities of antibiotics.

Chloromycetin in particular was deadly to many plants in his experiments. In others there is no noticeable effect on plant growth by the antibiotics.

Dr. Mitchell said that "right now everybody is working on this" and predicted that some means of controlling and stimulating plant growth might come out of the research.

Unfortunately for the farmer, the scientists have already found that bacteria in plants are like bacteria in humans in one respect — they can build up immunity to an antibiotic. In the laboratories at Beltsville, a bacteria strain resistant to the antibiotics has been developed.

No information has yet been received from field tests on the ability of bacteria in their natural surroundings to build immunity.

Every indication now is that these non-medical uses of the wonder drugs will be greatly extended by research and development. In 1952 antibiotic sales amounted to about $267,000,000 and the capital invested in the industry was estimated at $200,000,000.

In 1953 there was an impressive increase in antibiotic feed supplements for animals, and the use of the drugs on plants is just starting.

More than 100,000 species of molds are known, and they are so widely distributed that there is barely a spot on earth without some of them.

In Cuba, a new fiber crop, kenaf, has been established, assuring a Western Hemisphere supply of a jute-like soft fiber, for manufacture of bagging and other purposes.

Ghost Particle Found at Last

Neutrino Detected

➤ THE ATOMIC ghost particle has been trapped and proved to exist. The strange neutrino, needed for years to preserve subatomic balance, has at last been detected.

Drs. F. Reines and C. L. Cowan Jr., of the AEC's Los Alamos Scientific Laboratory, reported to the American Physical Society, at its recent meeting in New York, physical authentication of this strange sort of particle.

It was one of the most difficult searches for atomic particles ever undertaken. To find evidence for the neutrino, a particle so small as to have practically no mass and no electrical charge, the physicists used a scintillation counter that contained 75 gallons of liquid. It was thousands of times more sensitive than any other device to reactions caused by neutrinos. It was exposed to the intense bombardment of radiation from one of the AEC giant atomic reactors.

The chase of the neutrino began about 20 years ago when there was worked out what would happen when a neutron changed into a proton and an electron.

These three particles are the most important of the fundamental particles of matter. They are in the matter of atoms. Atoms are the fundamental stuff of everything. Neutrons are particles without electrical charge and are famous for triggering the atomic bomb. Protons are the nuclei of hydrogen atoms, the simplest known. Electrons can be thought of as particles of electricity.

In addition to mass and charge, these particles also have what is known as spin or angular momentum which arises out of complex but fruitful theory. The spin has to be conserved and that brought in the neutrino, which is Italian for small neutral one. Almost all this little particle has is spin. It balances out this atomic act, so-called beta disintegration, so important in so many atomic transformations.

The neutrino is so very small that scientists have often despaired of ever catching it free and away from its point of origin.

Calculations show that if a neutrino got started at the beginning of the universe, billions of years ago, it might still be going. It is that small.

It took a very large trap and a very large number of neutrinos to give any chance of detection. The trap was a great tank with chemical liquids, including cadmium compounds, that would promote the reaction in which neutrinos play such a small but balancing part. Only when things happened in just the way to affect properly three counters did the trap record a score.

The test consisted of taking score when the reactor was producing an immense radiation blast and when it was shut down. Because the score was significantly higher when the reactor was running and neutrinos abounded,

the physicists are confident that in this way they have "seen" the elusive neutrino.

Project Poltergeist, as Drs. Reines and Cowan nicknamed it, is to attempt to get still more evidence of the neutrino in the next year, with new and better apparatus. Meanwhile the textbooks that now say that the neutrino has never been detected will have to be revised. The noisy spirit among sub-atomic particles, the poltergeist of modern physics, has been caught.

Particles Given New Names

▶ A RE-CHRISTENING of fundamental particles of matter and a plan for naming new ones still to be discovered has been worked out by international agreement.

A new designation, *hyperon,* has been suggested for particles intermediate in mass between that of the neutron (particle that triggers fission in the atomic bomb) and the deuteron (nucleus of heavy hydrogen or deuterium).

The new alignment of symbols was made necessary by the large number of new particles discovered in recent years in cosmic ray collisions. There are now about two dozen so-called fundamental particles recognized. Some of them exist for only a fleeting fraction of a second.

The nomenclature got so confused that when experts gathered for an international cosmic ray conference at Bagneres de Bigorre in the French Pyrenees last year, a group worked out the new symbols and is now announcing them in various scientific journals.

Americans in the group include: Dr. B. Rossi of the Massachusetts Institute of Technology, Dr. C. D. Anderson of the California Institute of Technology, Dr. W. R. Thompson of Indiana University and Dr. B. Peters, now in Bombay, India.

Groups of particles are labeled with ordinary capital letters. Greek letters are used to designate specific particles, except that the old familiar *p* for proton, hydrogen nucleus, and *n* for neutron are retained.

Among the light mesons or L-mesons are the most assuredly known mesons, called *pi* and *mu*. Among the heavy mesons are: *Tau-meson* which decays into three pi-mesons. *Kappa-meson* which breaks down into a mu-meson and two neutral particles whose natures are still unknown. *Chi-meson* which decays into a pi-meson and a neutral particle of unknown nature. *Theta* (with O superscript) *meson,* which previously was known variously as v or V with O superscript and subscripts 2 and 4.

The hyperons are designated by Greek capital lambda, with superscripts of O to show its neutral nature or plus to show positiveness. These have been called V particles, from the kind of track they make in photographic emulsions where they are discovered.

Then the physicists have decided to call a *V-event* the decay in flight of a K-meson or Y-particle. An *S-event* is decay at rest.

While the re-christening brings a little more simplicity for the specialists, the whole situation is still very complex, compared with what used to be imagined when the only atomic particles really recognized were the electron, proton and neutron.

Some of the particles are known from only a few examples discovered in cosmic rays. The giant atomic accelerators, like the $20,000,000 machine generating 25 billion-electron-volt particles which will be operating at Brookhaven National Laboratory about five years from now, will duplicate immense cosmic energies and produce the rare particles plentifully. New ones will be discovered.

The stake of mankind in such research is understanding the ultimate nature of matter on the subatomic level. Considering that the whole atomic energy development has come out of atomic physics, the probing of these particles is one of the prime human endeavors.

Double Atomic Birth

➤ Discovery of an artificial "twin" birth process of still puzzling particles within the atom was announced as the result of about eight months of operation of the giant cosmotron of the Brookhaven National Laboratory on Long Island.

Dr. R. P. Shutt told the American Physical Society that it is now known that two particles, the relatively heavy hyperon and the lighter K particle, appear together when a proton smashes into a negative pi meson.

Heretofore, when the production of these very short lived particles was known only from cosmic rays, physicists were troubled by their lifetime, that they considered too long, even though it was only one ten-billionth of a second. The actual length of existence of the particles is made plausible by the production of the two particles in the same act.

Immense energies of the particles accelerated in the cosmotron made possible the artificial duplication of what the cosmic rays can do. The protons within the giant machine had energies of two and a half billion electron volts, while the pi meson was rated at one and a half billion electron volts.

Only several hundred K particles have ever been discovered in cosmic rays and they have never been found in pairs. The artificial production was detected by photographs of the tracks of the particles produced in a cloud chamber.

The K meson is 900 to 1,400 times the mass of the electron and the hyperon is 2,200 electron masses.

Such exploration of the constitution of matter and radiation is at the forefront of man's attack on the hidden mysteries of the atom. There is always the hope that some such new atomic discoveries will eventually be put to practical use.

New British Publication in Physics

➤ Reports of scientific discoveries in physics will be forecast in a new publication of the Physical Society, Britain's organization of physics. Each month a booklet containing abstracts of forthcoming papers is issued. Reprints of the papers can also be secured upon special order.

This new technique supplements the time-honored Proceedings which appear monthly in two sections, one devoted to original papers on nuclear, atomic and molecular physics, and the other to original papers on materials and other phenomena.

Astronomers Study Matter In Interstellar Space

Chemistry of Cosmic Dust

➤ THE TREMENDOUS rushing of gas and dust in interstellar space is due to a rocket-like ejection of material from around very hot stars.

Dr. Lyman Spitzer Jr., director of the Princeton University Observatory, N. J., presented this theory in the seventh Henry Norris Russell lecture at the American Astronomical Society meeting in Nashville, Tenn. Expansion of "hot spots" in regions around very hot stars, he said, may result in the turbulent velocities of the vast, interstellar clouds of gas and dust.

He explained what he called the "natural rocket" effect this way:

A dense cloud of neutral hydrogen constitutes a natural rocket when placed near a luminous star of high surface temperature. The stellar radiation heats up the cloud, on the side facing the star, to about 10,000 degrees (absolute).

The heated material expands, and shoots away from the cloud; since only one side is heated, the gas will stream away predominantly in one direction, towards the hot star. The recoil from this stream of gas will then accelerate the remainder of the cloud away from the star.

Stars May Throw Off Rays

➤ THE POWERFUL cosmic rays continuously bombarding the earth from space may be material thrown off from rotating stars with strong magnetic fields, Dr. Armin J. Deutsch of Mount Wilson and Palomar Observatories suggested to the American Astronomical Society.

Such stars, known to astronomers as spectral class A, are about 100 times as luminous as the sun, and have a mass two or three times that of the sun.

Dr. Deutsch's theory is that if an atom of interstellar hydrogen came very close to such a star, as close as ten times the radius of the star itself, the light energy of the star could split the hydrogen atom into the electron and proton of which it is composed.

Because of the star's strong magnetic and electric fields, the two particles, in just six seconds after their separation, would pick up energies of over 1,000,000,000 volts by moving a distance of one stellar radius along the star's lines of force.

Some of these energetic particles, Dr. Deutsch believes, might move out into space, where they would be further speeded up to become the powerful cosmic rays.

Intergalactic Space

➤ DETECTION of matter in the inconceivably vast spaces between the galaxies, the largest building blocks of the universe, has been suggested by Dr. A. E. Whitford of the University of Wisconsin.

One way to spot such matter would be to find a calcium line in the light from galaxies, Dr. Whitford told the American Astronomical Society's closing session.

Thirty years ago, astronomers were divided as to whether or not there is any matter in the spaces between the stars of our own Milky Way galaxy. Since then, however, they have found plenty of evidence not only that such matter is present, but that it may be the source of material for the formation of stars themselves.

Now, astronomers are divided as to whether or not intergalactic space, extending for millions of light-years between neighboring galaxies, is or is not completely devoid of matter. Such matter, Dr. Whitford suggested, might be detected by a calcium line in the light from other galaxies. The calcium line would be caused by the absorption of light of certain wavelengths in the invisible ultraviolet by atoms of ionized calcium.

Just such absorption lines in the light from stars in our own Milky Way galaxy first led to the discovery that there is interstellar matter in space.

However, although thousands of special photographs of other galaxies have been made, chiefly with the 100-inch and 200-inch telescopes, no intergalactic calcium lines have yet been detected. This appears to indicate that any matter in the spaces between galaxies is extremely rarefied.

Another possible method of spotting intergalactic matter, Dr. Whitford suggested, is the radiation of radio energy by intergalactic hydrogen at wavelength 21 centimeters. This perhaps could be observed against the "hot" background of another galaxy, such as the Andromeda nebula, if there were a very rarefied gas in the intervening space.

Jupiter's Atmosphere

➤ JUPITER's atmosphere is made up largely of hydrogen and helium, not methane and ammonia as was previously thought, the Carnegie Institution of Washington's annual report reveals.

Dr. William A. Baum of the Mount Wilson and Palomar Observatories and Dr. A. D. Code of the Washburn Observatory, Madison, Wis., have obtained the first direct observational evidence concerning what gases compose Jupiter's atmosphere. These are hydrogen and helium, they found from light curves of the gases composing the outer layers of Jupiter's atmosphere. The heavier gases, such as nitrogen and oxygen, that make up the earth's atmosphere are therefore believed to be almost absent on Jupiter.

Drs. Baum and Code made their observations when Jupiter eclipsed a bright star, Sigma Arietis, noting the rate at which light from the star was dimmed, then finally extinguished by the planet. To catch the star's disappearance with the 60-inch telescope, they used a photomultiplier, a sensitive instrument that steps up the star's faint light to record it electrically.

Drs. Edison Pettit and Robert S. Richardson, also of the Mount Wilson and Palomar Observatories, took motion pictures of the star's eclipse at the same time. They found remarkable variations in the brightness of the star about 50 seconds before it finally disappeared. These were due, they believe, to turbulence in Jupiter's atmosphere. Such marked fluctuations were also found with the photomultiplier.

The dimming and gradual disappearance were caused by the spreading

of the star's light as it was refracted by gases in Jupiter's outer atmosphere. A dense atmosphere would have caused the starlight to dim rather rapidly, but the actual observations showed that it faded out gradually.

The figure of 3.3 for the mean molecular weight of Jupiter's atmosphere agrees substantially with an estimate based on a study of Uranus and Neptune which showed that helium is about three times more abundant than hydrogen on those planets. If Jupiter had the same ratio, its mean molecular weight would be an estimated 3.5.

The findings of the two astronomers, at the present time, can be no more specific than that helium and hydrogen account for most of Jupiter's atmosphere. They do not indicate how much of each gas is present or what other elements may exist there.

Shooting Stars

➤ THE "SHOOTING STARS" which streak across the sky may have been born in a giant cosmic collision 100,000,000 years ago.

In a symposium at Boston, the American Association for the Advancement of Science was told that two asteroids may have collided while circling the sun as the earth does.

Dr. Harold C. Urey, University of Chicago Nobel Prize Winner, reported that the asteroids may have been formed four and a half billion years ago, according to the new doubled time scale. This is about the period when the solar system itself was formed. The asteroid was formed when black, soft, water-containing cosmic objects merged into large and small planets.

The planets heated, melted and later solidified. Then one asteroid plowed into another of about the same size, breaking it up and scattering the debris.

Dr. F. A. Paneth of the University of Durham, England, and Dr. S. F. Singer, University of Maryland, reported that the time at which meteorites were formed can be determined by studying the helium content of the meteorite. When the molten cosmic mass solidified, the uranium it contained was decaying. This was producing lead and helium. But when the meteorite was sent hurtling into space by the big collision, cosmic rays acted upon the meteorite's iron, producing a measurable helium isotope.

By comparing the helium isotope with the uranium-born helium, scientists have determined that meteorites are not as old as generally supposed. "Old" meteorites, previously thought to be billions of years old, actually are about 100,000,000 years old.

Two New Radio "Stars"

➤ DISCOVERY of two new radio "stars" in our galaxy was reported to the American Association for the Advancement of Science meeting by Fred T. Haddock of the Naval Research Laboratory, Washington, D. C.

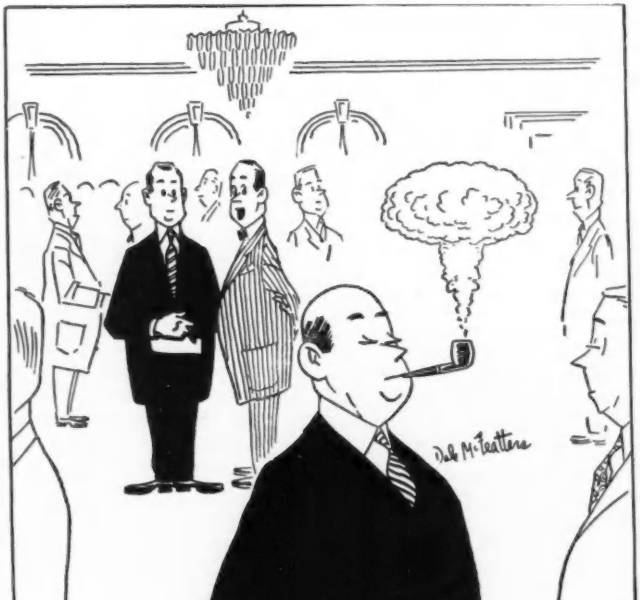
The measurements, the first successful at the very short wavelength of nine centimeters, were made at the laboratory with the 600-inch radio telescope, a huge metal saucer aimed at the heavens. Nine centimeters is about four inches, compared to wavelengths of about 1,000 feet for frequencies in the middle of the standard broadcast band.

One of the new radio sources, de-

scribed by Mr. Haddock as a "nebula," is in the Great Nebula of Orion, a familiar winter constellation now visible in the southeastern sky. There are three stars in a row that form the sword of Orion, the warrior, and the Great Nebula's place is marked by the middle star of the three. The Great Nebula in Orion is the biggest and brightest of the nebulae in the heavens.

The other radio nebula discovered by Mr. Haddock and his co-workers, including Cornell H. Mayer and Russell M. Sloanaker Jr., is the "Swan" nebula, not to be confused with the constellation, Cygnus, the swan.

All of the objects so far spotted at the nine centimeter, or 3200 megacycle, range have been identified with visible objects, but the only two new sources so far discovered at this short wavelength are the Orion and Swan nebulae.



➤ "UNDERSTAND *he's a big man in atomic energy!*"

Atomic Engineering Problems in Application of Nuclear Fission

Atomic Energy Depends on Research

by HENRY DE WOLF SMYTH
Member United States Atomic Energy Commission

Extract from an address, "The Future of Research and Development," made to the National Alumni Association of Princeton University.

THE PRINCIPLE of energy released by nuclear fission was unknown before 1939 and was discovered in connection with completely abstract researches on the nature of atomic structure. There was no practical experience which could be combined with this scientific discovery because nuclear reactions do not occur on the earth's surface in noticeable degree.

The layman might suppose that only the central idea was novel and that putting it to work was a job for men with practical experience. This was partly true, but not so much as you might think. Let me talk about some of the practical problems of building a plant such as the one at Hanford, Washington. Let me take two illustrations, both of which would appear to be familiar problems from the engineering point of view. The process of nuclear fission which was to occur on a large scale in the Hanford reactors releases enormous amounts of heat. This heat had to be removed from the reactor in some way. Certainly, the design and construction of a cooling system appears to be a straightforward engineering problem. As it turned out at Hanford the new requirements imposed on such a cooling system by the nature of the nuclear processes going on in the reactors required extensive modifications of the normal technology for cooling systems. Neither copper, nor iron, nor lead, nor stainless steel piping could be used. The presence of any one of these materials in the reactor would prevent the reactor from working. From the nuclear physics point of view zirconium or beryllium would have been ideal. Neither zirconium nor beryllium piping existed, nor was it possible to develop it for use on the scale that was required. It turned out that aluminum could be used but that the aluminum pipes had to be thin. Not very much was known about the corrosion of aluminum when hot water was running through it, and nothing was known about the effects of the nuclear radiation on aluminum. Consequently, before the plant could be designed and built it was necessary to make many tests on properties of aluminum piping.

The chemical plant was to process large amounts of uranium and to remove from it minute quantities of plutonium. Uranium had been known for many years but had never been produced in quantity before nor processed chemically on any major scale. Plutonium was a totally unknown chemical element first discovered in 1939. Furthermore, materials to be processed in the plant were highly radioactive and, therefore, the whole

plant had to be designed for remote control to protect the operating personnel. And it had to be further recognized that the presence of radioactive radiations might affect chemical processes just as the presence of similar irradiations affected the corrosion of aluminum.

Evidently the solution of both of these problems and a host of others that were present required the cooperation of engineers with practical experience and scientists who were familiar at least on a laboratory scale with the new effects that were involved.

In general, the use of atomic energy in weapons or in reactors involves unfamiliar materials working under entirely new conditions like radiation fields or under extremes of pressure, temperature, and so on. There is no practical experience to draw on.

There are many other industrial fields where similar conditions prevail today even if there is a background of continuous evolution from an origin in common every-day experience. Most of the great industrial developments of the nineteenth century had their origin in an inventor's workshop. The corresponding developments of the last thirty years have usually come from scientific laboratories.

The Effect of Two World Wars

This increasing dependence of industrial technology on scientific research is largely the result of the natural trend of industry and the growth of a large body of scientific knowledge. But the trend has certainly been accelerated by the political history of the last forty years. Even World War I showed how quickly scientific results could be put to practical use if the motivation was strong enough and cost was a secondary consideration. In 1917 and 1918 a large amount of research and development work was carried out at government expense in such fields as chemical warfare, communications, and aviation.

Between the two world wars such Government supported scientific work for military purposes dwindled greatly but did not entirely stop. Some of it was diverted to civilian aims or to problems that had both civilian and military interest.

Even before our formal entry into World War II, we began to build up Government supported scientific research on military problems. The great sums and great effort put on the development of radar, proximity fuses, and atomic bombs, as well as more prosaic devices were major factors in winning the war. Some of this effort particularly in the field of atomic energy continued after the victories of 1945. In the last three years our increasing concern for the defense of the Western World has again increased the support given to research and development until the expenditures have reached the large totals I have cited.

Evidently war and fears of war have accelerated the pace at which new products and processes have been developed and have led the Federal Government to intervene on a scale that could not have been anticipated forty years ago.

Regardless of the causes of the closer association between industry and science, I believe that the value of

this association has been so clearly demonstrated for both the Government and private enterprise that it will continue.

Questions for the Future

If we assume that scientific methods and scientific data are going to permeate our whole industrial scheme more and more—that pre-eminence in scientific and technical research is going to be more important to the welfare of the nation both in the arts of peace and in the technology of war—then we must face certain basic questions, which I have mentioned earlier: Who is going to do this research? Where is it going to be done? Who is going to pay for it? If a large share of the cost is to be borne by the Federal Government, how are the fruits of the work to be made available to our private enterprise system?

Obviously the research work is going to be done by the scientists and engineers of the country. The first point that arises is the probable shortage of people with this training because we evidently need men not only to do research and development but to understand it sufficiently to make full use of it and to appreciate its effects on industry and on the technology of war. I shall not go into the question of how the number of competent people might be increased. I am going to assume that in some way that will be taken care of and devote myself to some of the other problems involved.

At present the sort of research I have in mind is divided among four kinds of institutions. They are: universities, industrial laboratories, Government laboratories, and laboratories of independent foundations. (This last category is very small.) I believe the three principal types of laboratories—university, industrial, and Government—will continue to exist, and in fact, will probably multiply. Though their functions are now overlapping and probably should continue to be so, it is possible to differentiate the areas in which each of them should concentrate their efforts.

University Laboratories

It is generally conceded that universities are the best places in which to do basic research—research which is aimed at discovering more and more about the laws of nature regardless of the possible utility of these discoveries. This country has been relatively weak in this field in the past and has depended largely on Europe for discoveries in basic science. Consequently, both the weakening of science in Europe and the increasing importance of basic research to industrial development suggest a very much more intense effort in this country in this field.

During the war, it was demonstrated that universities were excellent places to carry on applied science aimed rather directly at devices of military usefulness. Much work of this kind has continued since 1945 and particularly since the outbreak of the war in Korea. I doubt whether it is desirable in the long run that scientific departments of universities should do very much of this type of work. Probably the successes of the war period were the results of university scientists turning to problems of applied science with great determination and also with freshness of mind. For the long pull, I think the scientific departments of the universities should

confine themselves very largely to basic science.

In what I have just said, I have been careful to specify scientific departments of the universities. The function of the engineering departments is somewhat different. Probably they should not normally devote their efforts to the development of specific machines or processes. To my mind, the work that is going on at the Forrestal Research Center is very much the kind of research that should be carried on in engineering departments. The problems they are working on are not specific engines or planes, but are in areas which will clearly be helpful in the future design of engines and planes. The choice of research problems is not as completely free as it should be in the science departments. Problems are chosen with ultimate utility in mind, but areas of inquiry are chosen rather than specific applications. For example, work may be done on problems of combustion at high temperatures or on the properties of metal at high temperatures knowing full well that information obtained in these areas will be useful to the builders of jet engines even though no particular jet engine may be in view. Apart from motivation there is little difference in nature between this modern engineering research and basic science.

Industrial Laboratories

In industrial laboratories the nature of the work to be undertaken naturally varies enormously with the complexity of the interests of the company which supports it. A small company manufacturing a limited number of products would probably confine its research to the testing and improvement of those products. A company with a great diversity of interests and variety of products might on the other hand support research in general areas very much of the kind I have suggested as appropriate for university engineering laboratories. This has certainly been the case in several of our large industrial laboratories. In fact, some of the men in our largest industrial laboratories have contributed conspicuously to basic scientific research, yet I think it is clear that the bulk of the work, like that of the RCA laboratory here at Princeton, is either in general areas of interest to the company or on specific products which need improvement.

Government Laboratories

There remain Government laboratories of which at present there is a great variety. The ones that have the simplest objectives and are most clearly differentiated from industrial or university laboratories are those of the Armed Services. If we take four examples—the Naval Research Laboratory and the Naval Ordnance Laboratory in Washington, the Ballistics Research Laboratory at Aberdeen, and the Signal Corps Engineering Laboratories at Fort Monmouth—we see that a considerable variety of interest is covered but that all the work is properly directed to the general objective of improving the tools of war. However, the art of war has now become so complex that the range of problems covered in these laboratories is very wide and in many cases overlaps the interests of industrial or even university laboratories.

The Bureau of Standards is one of the oldest of the Government labora-

tories and serves a very special purpose. Its principal function is that implied by the name—to maintain standards of measurement of all kinds. These include not only obvious things like length, weight, and temperature, but also such things as standard-strength sources of radioactivity. These are very important responsibilities and clearly belong in a Government laboratory. Associated with them are a variety of interesting scientific problems and testing problems.

The laboratories of the National Advisory Committee for Aeronautics are a noteworthy example of Government supported laboratories which work on problems that are of interest both to the civil aviation industry and to the Air Force. Since it is hard to say to what degree the aviation industry is really private industry, it is even more difficult to say to what degree the funds used for research work in the NACA laboratories are going to the support of private industrial enterprise.

The four major laboratories of the Atomic Energy Commission cover a variety of activities. Their nature arises from the monopolistic character of the whole atomic energy industry. These laboratories are, indeed, the research centers for an entire industry—one of the largest in this country—and one which exemplifies vividly the immediate application of scientific research. The atomic energy enterprise is so new and works in such unfamiliar territory that research is of the utmost importance to it and must remain so for some time. A large share of what is done in AEC laboratories is of industrial or semi-industrial kind. We in the Atomic Energy Commission have recognized that universities are probably the best places for our basic scientific research, and we support such research extensively.

The Atomic Energy Commission sponsors basic scientific research in its own laboratories in cases where the research is closely related to the technical problems, or in cases where the required equipment is so large or so expensive that it cannot be properly done in a university laboratory. Our Commission laboratory at Brookhaven is perhaps the clearest example of basic research outside universities. At Brookhaven, the Atomic Energy Commission has set up a large laboratory with equipment so expensive both to build and to operate that it would hardly be appropriate on a university campus; yet, the work done at Brookhaven is largely basic scientific research. Brookhaven is operated by an association of nine eastern universities of which Princeton is one, as you know. So far it has proved a productive though sometimes uneasy marriage of Government funds and university research spirit.

Financial Support of Modern Research

This brings us to the question of the cost of research. I have said that basic scientific research should be done in university laboratories. Unfortunately the cost of basic scientific research has gone up enormously in the past twenty years. The incomes of our great universities, notoriously inadequate for the jobs they undertake, have not gone up correspondingly. This has meant that either the work had to be shifted out of the universities or the universities had to receive

outside financial support. Both courses have been followed to some extent, but the greater emphasis has been on support of research in universities by the Government or by private industry.

Obviously, all this outpouring of money for research and development is primarily the result of the war. Should so large an expenditure continue? I believe it is justified in terms of the trends I have tried to explain, because I am sure we are only beginning to see what richness is uncovered by the application of science and scientific methods. The second question is whether so large a portion of this expense should be borne by the Federal Government. As long as so much of the effort is directed at increasing our military strength, there can be little doubt that the Federal Government should pay the bill. In terms of our hopes of a peaceful world the question is more difficult to answer. Clearly the applied research aimed directly at increasing the profits of a particular company should be paid for by that company. At the other extreme, basic research in the universities should ideally be paid for by the universities, but practically we are very well aware of the fact that they are at present unable to do so. Nor does it seem to me very satisfactory to have them entirely dependent on contributions from private industry. Either Government support or support by industry brings with it many dangers, such as irrational and unexpected budgetary cuts or crippling interference of direction and control. In a Utopian, stable period of peace, one might hope that the universities would become capable of paying for this kind of work themselves. Until that time, we must do our best to preserve the spirit of teaching and free inquiry which makes universities the best places for basic research and to work for as much enlightenment as possible in the granting and administration of funds for their work.

There will surely remain such areas as the work of the Bureau of Standards as proper Federal functions. There probably will also remain areas of applied research which are too speculative for private industry, too expensive for universities, and yet too potentially valuable to be neglected.

Perhaps the work of the NACA is an example of this type, or some of the work that the Bureau of Mines does in developing new metals or new ways of processing raw materials, but the most striking example, I think, is the development of nuclear power.

Transfer from Federal to Private Support: Atomic Power

The atomic energy enterprise focuses sharply the question of how the fruits of Federally supported research and development are to be absorbed into our private enterprise system. This is not an entirely new question since it has certainly been met in the activities of various Federal bureaus concerned with agriculture, forestry, fisheries, and the like, as well as in the NACA and Bureau of Mines work cited above. But the question is new in degree because of novelty, magnitude and secrecy of the atomic energy enterprise. The way in which this development is handled may be a pattern for the future. Let me examine briefly the present and future relations between Government and private industry in the atomic energy field.

Born of a war-time need, the atomic energy industry has great possibilities for peacetime uses. For this reason, you have heard a great deal recently about turning it over to private enterprise. The Commission has been studying this possibility for several years. It is not entirely simple. I must remind you that the work is now carried on by private companies. Of the 145,000 people now working in the atomic energy industry a little less than 7,000 are direct Government employees. The rest are the employees of such companies as General Electric, du Pont, Carbide and Carbon, Westinghouse, and many others, as well as those working on our research contracts with Princeton, Columbia, MIT, Harvard, and many other universities.

Most of our AEC employees and plants are engaged in making materials for atomic bombs, but the Commission is aiming at the production of electric power from uranium. We do not know yet whether this can be done cheaply enough to compete with other sources of power. We will not know until a power plant has been built and operated. Perhaps the first two or three will lose money. It is not likely that even our larger companies will be willing to run the risks that are involved in carrying out this development. None of them has any experience in this field except as a contractor of the United States Government, yet it seems evident that we should not forego the exploration of this source of power even though its development may be expensive.

The original reasons for Government monopoly in this field were: the need for secrecy; the need for safeguards in the matter of health; and the absolute necessity for making sure that no atomic explosives escape from Government control.

All these reasons for monopoly still exist. We could maintain the present Government monopoly indefinitely even if it meant putting the Federal Government still more into the power business. The Atomic Energy Commission would then make and sell power as well as producing weapons.

The objections to this course of action seem to me to outweigh the difficulties of transfer to private industry. The legal, political, social, and economic questions involved in such a transfer can be solved, and there are many compelling arguments in favor of getting at least civilian power development into the normal channels of competitive private enterprise. Of course, the Government's responsibility for weapons will have to be protected as long as they are needed. There must be adequate public discussion, and the change from Government monopoly to competitive private industry must be gradual over a long period of time if it is to be fairly and wisely carried out.

I hope that the transfer can be achieved so effectively that it may set a pattern whereby the Federal Government may carry out research and development and even initiate new industries in areas too big for private capital without affecting the independence and competitive vigor of our industrial system.

There are four basic types of guided missiles: surface-to-surface; surface-to-air; air-to-air; and air-to-surface.

Powerful Rocket Fuel Source of New Wonders

Hydrazine — New Chemical Giant

by HARLAND MANCHESTER

➤ FOR YEARS a chemical called hydrazine, which looks like water and smells a bit like ammonia, was considered a mere laboratory curiosity. Then, during the war, German chemists made it into a rocket fuel of tremendous power. In so doing, they pried open the door to a treasure house, for hydrazine is now working miracles in a dozen fields.

One of its derivatives is isoniazid, a promising new TB drug. Another is maleic hydrazide, which retards growth when sprayed on grass, thus reducing the frequency of mowing; it also keeps potatoes from sprouting in storage, and has many other promising uses in the regulation of plant growth.

Because of hydrazine, some automobile radiators last longer, and industrial boilers are protected from corrosion. Hydrazine has been used to make plastics and synthetic fibers with superior properties. Many other possibilities are being investigated for it has opened an entire new field of chemical exploration.

Hydrazine was first used during the war. In the summer of 1943 a strange, torpedo-shaped aircraft with stubby swept-back wings was rolled from a hangar near Bremen. Taking off, it sped through the sky like a shooting star, emitting an unearthly roar and a blue-yellow exhaust plume. After this test flight the jubilant pilot reported incredible climbing power and a top speed of 640 miles per hour.

This was the world's first operational rocket plane, the Messerschmitt 163-B; the hydrazine in its fuel tanks burned with the help of oxygen supplied by hydrogen peroxide carried in other tanks.

In a frantic effort to stem the Allied onslaught, the Nazis built 300 of these planes. Soaring high and diving from the sun, they took savage toll of British and American aircraft during the war's closing months.

Another hydrazine-fed rocket plane climbed seven miles in one minute. Since then the little terror, copied and improved by the major powers, has revolutionized aerial warfare.

When the war was over, a captured "163," a supply of the hydrazine fuel, and the plane's German designer, Dr. Alexander Lippisch, were taken to Muroc Lake, Calif., for further experimentation. Britain also got the "163," and two escaped Russian engineers report that the Soviet Government obtained several from the Junkers plant in East Germany, along with tools, dies and technicians, and is working on advanced types for use against high-flying bombers.

In peacetime aviation, many experts are predicting that high-flying rocket planes will take over long-distance flight. There are other rocket fuels, but the construction of big hydrazine plants in the United States points to it as the fuel of choice.

Last year the Fairmount Chemical Company of Newark, N.J., which has been making small amounts of hydrazine since 1940, stepped up production fourfold, and the Matholin Corporation, a new firm set up by the Mathieson Chemical Corporation and Olin Industries, Inc., opened a $3,000,000 plant in Lake Charles, La. It is estimated that the two plants are turning out more than 300,000 pounds a year of the chemical, and that this output can be increased tenfold in a short time if needed.

Hydrazine is made from ammonia (or urea) and chlorine and caustic soda—all cheap and plentiful materials—but the production process is long and involved. Its cost has been about $50 a pound. Last year Matholin slashed the price to $2.50 a pound, and believes that with tonnage production the price may be cut to 50 cents. Every price cut makes more uses possible.

One of the most dramatic benefits of hydrazine is in the new TB drug, isoniazid. A few years ago, the drug was created in the laboratories of two American drug firms—E. R. Squibb and Sons, and Hoffman-La Roche, Inc.—and by the Bayer Company of Germany, all of whom were searching independently for TB cures. Without knowledge of the others' work, each group tested the drug on laboratory animals which had been given TB, and each obtained striking results. As the result of one experiment, tuberculous mice given this obscure compound—now called isoniazid—in the Squibb plant were alive and scratching ten days after they should all have been dead. Work was intensified to find out how the drug behaved and if it were safe for people.

In February 1952 the TB drug made a premature front page splash, while doctors and drug firms, who were not yet sure of its value, shook in their boots. It was being tried out independently at the New York Hospital-Cornell Medical Center and at the Sea View Hospital at Staten Island, N.Y. The death of some early users caused a reaction against isoniazid, although they were hopeless cases, and no drug can restore destroyed lung tissue.

While not all answers are known after two years of use, the smoke has cleared enough so that most doctors see in isoniazid a valuable tool in TB treatment. Now used in most hospitals throughout the world, the new drug, often given in conjunction with streptomycin, is producing results. The New York City Health Commissioner recently reported that the TB death rate had dropped 21 percent in the previous 11 months, and that for the first time in many years there were empty beds in the city's TB hospitals. The improvement was laid largely to new drugs, particularly isoniazid.

Isoniazid is given in pills and by injection, is cheaper than other TB drugs (cost: about 75 cents a day) and is remarkably safe to use. Standard methods of treatment—bed rest, fresh air, surgery and the use of other drugs —are still necessary. But there is no longer any doubt that isoniazid has brought a great advance in the control of TB.

Other derivatives of the rocket fuel are being tested to combat other ailments. One compound shows promise

in reducing blood pressure; another is effective in clearing up urinary tract infections, and a third, added to feed, seems of value in treating the poultry disease, coccidiosis.

An accidental discovery made six years ago by a young man from Missouri resulted in the production of maleic hydrazide, known as MH-40, a hydrazine derivative which will control the growth of plants. It was the job of Dr. D. Lorin Schoene of the Naugatuck Chemical Company, a division of the U. S. Rubber Company, to build new chemical compounds and try their effect on plants. He had sprayed some 500 compounds on greenhouse tomato plants with no notable results. When he wet down a plant with MH-40, it developed into a squat dwarf.

This effect was so striking that it suggested endless useful possibilities in putting a "stop order" on growth, dwarfing a whole plant or a part of a plant at will. Soon the experimental greenhouse was full of dwarfed plants of many varieties, standing beside their tall, untreated brothers. A variety of jungle grass, which normally grows waist high, stopped at about an inch after being sprayed with the new compound.

The first large-scale use of MH-40 came three years ago when the Connecticut Highway Department sprayed 250 acres of center strip and shoulder of the Merritt and Wilbur Cross express highways. Grass must be kept short on these landscaped areas for visibility in driving, and frequent mowing is expensive. The chemical, which was sprayed on the grass from a moving tank truck, slowed down growth to the point where only two mowings were needed throughout spring and summer, while untreated areas had to be mowed 19 times. MH-40 saved the taxpayers $70 an acre, and since then highway departments in 14 states have been testing or using it, and Armed Services establishments use it to suppress grass near ammunition dumps to prevent fire hazards.

MH-40 is not yet recommended for entire lawns because it is difficult to apply evenly with hand equipment and may cause brown patches, but last year it was placed on the market under various trade names for use on lawn borders which the mower cannot reach, to reduce the arduous work of clipping. It has a useful future in suppressing rank grass on roadsides, vacant lots, orchards or hillsides where billiard-table smoothness is not essential and where a scythe would otherwise be needed. It will not retard weeds, but can be mixed with chemical weed and brush killers. Thorough tests have shown it to be harmless to animals who may eat the sprayed grass.

As a "sleeping pill" for plants which makes them inactive for many months, MH-40 promises to save millions of dollars for farmers and housewives. When potatoes are kept in storage for a long time long sprouts grow, drawing the food out of the spuds and making them spongy and worthless. Prof. S. H. Wittwer of Michigan State College went hunting for something that would check this sprouting when sprayed on the potato tops before harvest. He tried MH-40 with remarkable results. A trace of the chemical permeates the plant to

the tubers and puts the concealed buds to sleep for an entire winter.

While eight months after harvest, normally stored potatoes had grown long sprouts and were badly shriveled, treated potatoes from the same field were firm and fresh with their eyes still closed. The Pure Food and Drug Bureau tested and O.K.'d the treated potatoes. Color, flavor and taste remain the same, and there is even some improvement in quality, for there is less change from starch to sugar than in most winter-stored potatoes. Many growers are now using MH-40 successfully, and it shows great promise of matching supply to demand more evenly throughout the year.

Sprayed on onion tops before harvest, MH-40 will keep the stored onions from sprouting for at least a year with no loss of quality, and it has also been used with excellent results on carrots, beets, parsnips and turnips. Other possibilities are being explored by Dr. David G. White of Pennsylvania State University. By spraying the top limbs of apple trees with the chemical and thus discouraging upward growth, Dr. White has produced semi-dwarf trees with low-hanging limbs from which it is easier to pick the fruit. He has also been testing the chemical on flowering fruit trees to delay their blossoming in the early spring until danger of frost is over, and to check the growth of runners on strawberry plants in order to increase the yield. And he reports that when head lettuce was sprayed before harvest, the decrease in "breathing" prevented internal decay.

Consumers are already reaping unseen benefits from the new chemical. Crepe rubber shoe soles are lighter and absorb less moisture because of a hydrazine compound. Introduced into the mix during manufacture, it frees nitrogen gas, leavening the rubber with millions of tiny sealed bubbles. This improved crepe rubber is also used to make lighter and more durable life rafts, fishing floats, rug underlays, insulation for refrigerator doors, and ultralight plastic beachboards.

Another chemical based on hydrazine has been used for two years in soldering the radiators of Ford cars to prevent corrosion. Used in the ovens when the radiator cores are baked, it removes all traces of corrosion-causing chemicals. A dash of another hydrazine compound, added to the water in the boilers of steam power plants, prevents corrosion and has made important savings in the last year.

Many projects are under way for developing entirely new lines of plastics and synthetic fibers containing hydrazine. The Celanese Corporation of America and its British affiliate have taken out 23 patents for superior nylon-like fabrics said to be more absorbent and therefore less clammy in warm weather than present synthetic fabrics. For decades chemists have been searching for a super-hard plastic which won't scratch easily; hydrazine may give them the answer.

More than a hundred U. S. firms and universities are now working on projects for putting the new chemical to additional uses. Scientists predict that cheap hydrazine by the ton will result in a new bonanza of discovery and invention.

This article will appear in *Reader's Digest* in condensed form and is published in cooperation with that publication.

$20,000,000 For 25-Billion Volt Atom Smasher at Brookhaven

Strong Focus at Brookhaven

➤ THE U. S. will build a 25-billion-volt atom smasher at Brookhaven National Laboratory, Upton, N.Y., the Atomic Energy Commission has announced.

Estimated to cost $20,000,000 before completion, the giant particle accelerator will mimic, under man's control, some of the power unleashed by the cosmic rays continuously bombarding the earth. The machine, known as an "alternating gradient synchrotron," will use the new, strong-focusing idea worked out nearly two years ago.

The strong focus is developed by using many small magnet sections, rather than the larger ones now common, to focus the whirling atomic particles. The small magnet sections act somewhat like the concave-convex mirror systems used to focus light.

The new accelerator will develop more than eight times as much energy as the present world's largest atom smasher in operation, the cosmotron at Brookhaven, which has operated at 2.3 billion electron volts and is expected some day to reach 3 billion, at the lowest level of cosmic ray energies.

The bevatron, under construction at the University of California's Radiation Laboratory at Berkeley, is expected to accelerate particles into the 5 to 7 billion-electron-volt range.

A European group known as the Council for European Research, Nuclear, CERN, is making plans for a 30-billion-electron-volt accelerator, also using the strong focusing principle.

Powerhouse For New Plant

➤ TWO NEW power plants now are under construction in Ohio to supply the Atomic Energy Commission's new gaseous diffusion plant with 15 billion kilowatt hours per day.

Termed the largest single power contract in the 74-year history of the electric utility industry, the project is to be completed by June 1, 1956, although the first generator will "go on the line" by Jan. 1, 1955.

The project, costing an estimated $400,000,000, is being financed by insurance companies, banks, stocks and other private sources, Philip Sporn and Vernon M. Marquis of the American Gas and Electric Service Corporation told the American Institute of Electrical Engineers.

More than a score of utilities are cooperating in the project. Two new companies, the Ohio Valley Electric Corporation, and its subsidiary, the Indiana-Kentucky Electric Corporation, were formed as an initial move in implementing the project.

To be built near Madison, Ind., and Gallipolis, Ohio, the two powerhouses will be 142 and 50 miles, respectively, from the AEC's diffusion plant. The plants will be linked to the AEC installation by 400 miles of 330,000-volt transmission lines, and will consume 7,500,000 tons of coal yearly. The coal will come from the Western Kentucky-Southern Indiana fields and the Ohio Appalachian fields.

▶ THE HIGH SCHOOL *science fair held at Allentown, Pa., in 1953 filled the gym with exciting exhibits and drew a record attendance of townspeople. Here the judges are shown examining the entries of the students, preparatory to making awards to those who best carried out the projects they set for themselves.*

Science Fairs For Teen Agers

▶ "SO WIDE are the horizons of science that there is no room for the narrow minded."

These words are sent in greeting by a science fair participant of another year to this year's group whose projects will make up the National Science Fair.

High school students from all sections of the country are holding exhibits of the projects in science which they have built, learning while building. They have found out that in order to explain to passers-by their scientific interests they must learn very thoroughly the subject they are trying to demonstrate.

Here lies the importance of science fairs as culminating events dramatizing the work of pupils in science courses in high school and the recreational side of science brought out in science clubs. Scientists are essentially people who manipulate their environments. In the exhibits they build to explain their interests, young scientists can show how they change and improve the world around them. They can also show the value of such work to the audience of passers-by who have not seen or understood it before.

Two points of view concerning science frequently cause conflict in the minds of people who are just coming to realize the extent to which science dominates daily life today.

On the one hand, there is the romantic attitude cultivated by many advertisements which picture the scientist as a selfless idealist living only to benefit his fellow man. (The benefitting agent is, of course, the gadget the advertiser has for sale.)

On the other hand, fear of atomic

▶ AN ELECTRONIC *switch was assembled and demonstrated by Robert Tinsman of Liberty High School as his project in physics at the Allentown Science Fair.*

warfare conjures up nightmares of scientists scheming in secret to destroy the world. Such fear is a potent tool for unscrupulous politicians whose strength comes from cultivation of ignorance.

Nothing combats ignorance like a clear and understandable presentation of truth. An exhibit of the work scientists are doing to promote health, establish sanitation, improve antibiotics, create better materials, work out the history of the planet, explore causes of weather, increase the food supply, grow disease resistant crops, promote better communication, understand human difficulties and lessen useless misunderstanding can be a revelation to the audience which comes to see it.

But a greater value comes to the student who follows from first "bright idea" to completed model the demonstration of the particular corner of science that appeals to him. Narrowing to a sharp focus the project that he wants to present, planning the layout to include the essential features and constructing the exhibit within the limits of space, time and money available teach valuable lessons.

Explaining the project to the varied people who come to see it is an examination at once more stimulating and more thorough than any the student takes in class.

All over the United States, boys and girls are finding it fun to participate in science fairs. And their elders, teachers, scientists and leaders in their communities are finding new enthusiasm in helping put on these constructive shows.

▶ EXTRACTION *of elements from sea water won second place in chemistry for Richard Steyert of Allentown High School in Allentown's Science Fair.*

A healthy competitive spirit leads local fairs to send on their best representatives to meet teen age scientists from other localities at the National Science Fair. Each year this becomes a more popular event, more representative of the country as a whole. This spring it is expected to be bigger and better than ever.

The National Science Fair is expected to double its size in 1954.

Last May (1953), 30 areas scattered throughout the United States were represented at the national fair held in Oak Ridge, Tenn. This year, about 60 areas may send delegates to the national fair at Purdue University, Lafayette, Ind., May 13 through 15, 1954.

This means that competition will be even tougher for the teen-aged scientists who will enter their exhibits that

won top place in their local fairs. If the expected number enter the National Science Fair, about 120 high school students will be in competition. Each local fair can send two finalists to the national event.

The grass roots of the national fair have spread this year even into Canada. Students in a small southern section of British Columbia will be able to seek entry into the National Science Fair through the Inland Empire Science Fair, to be held in Seattle, which covers also parts of Montana, Idaho, Washington and Oregon.

All science students in New Mexico, Indiana, West Virginia, Delaware and Rhode Island now have a local fair to enter. About four-fifths of New Jersey and all but the four northwest counties of California are covered by local science fairs.

About two-thirds of Tennessee, North Dakota and Washington, half of Connecticut, one-third of Arizona and one-fourth of Idaho now have local fairs of their own.

Aimed at encouraging interest in science at the grass-roots level, the National Science Fair is sponsored by Science Clubs of America, administered by Science Service. Last year about 10,000 science-minded high school students competed for national honors through their local fairs. A half million persons saw the exhibits made by the teen-agers and 15 million learned about the program through their local press. This year these totals will more than double because much larger areas are involved.

Termites Eat Arsenic, Lead, Concrete

➤ TERMITES thrive on arsenic on Barro Colorado Island, the Smithsonian Institution's tropical research center in the Panama Canal Zone. And others of the 42 recorded termite species on the island do such versatile things as gnaw through lead and concrete or carry fungi with them to kill wood so they can eat it.

With such a talented termite population, Barro Colorado has become a center for termite control research.

James Zetek, director of the station, is in charge of anti-termite work there. Up to now, he has made nearly 35,000 tests, using woods impregnated with various repellents and poisons. About 400 different forms of treatment against termite attack have been tried out on the various woods, some with success, but most merely a testimonial to the termites' near-indestructibility.

The reason termites are hard to dispose of completely by poison lies in the way they obtain their nourishment. Termites eat wood for its cellulose content, but they alone cannot digest it. Special bacteria living in the termites' digestive tract break down the cellulose into a form which can be used by the termites. Without the bacteria, they would starve to death surrounded by food.

Thus, one of the best ways to kill termites would be to poison their bacteria. But, just as bacteria build up strains that resist penicillin or streptomycin, the termites' bacteria after a few doses of poison may form strains that are unaffected by it.

One race of Barro Colorado termites has thus acquired the ability to crunch heedlessly through arsenic to get to a tasty morsel of poisoned wood.

For The Home Lab

Organic Reactions: Oxidation

Part II

by Burton L. Hawk

➤ In our previous introductory discussion on oxidation, we considered the reaction on primary alcohols and aldehydes. We found that the alcohols were oxidized to aldehydes and the aldehydes to acids. Now we should like to broaden our consideration of the oxidation reaction to include other types of compounds.

First, let us prepare the dichromate oxidizing agent which we shall use in several of the following reactions. Two grams of sodium (or potassium) dichromate are dissolved in 20 cc. of water. Cautiously add 4 cc. of con. sulfuric acid. Mix thoroughly and cool the solution.

Isopropyl Alcohol

What happens when a *secondary* alcohol is oxidized? In this case, the corresponding ketone is obtained, instead of an aldehyde. The oxidization of isopropyl alcohol to acetone will illustrate.

Pour about 3 cc. of the dichromate solution prepared above in a test tube and add 10 drops of isopropyl alcohol. Shake gently. After a short time, you should be able to recognize the mint-like odor of acetone.

Acetone

Acetone can be further oxidized to acetic acid, although not as readily as the alcohol. Using a fresh portion of the dichromate solution, add 10 drops of acetone. Shake and heat, but do not boil. Continue this procedure until the solution darkens and you can determine the odor of acetic acid. Carbon dioxide is also formed.

Glycerin

While we are on the subject, we must include the spectacular oxidization of glycerin. Glycerin is oxidized so rapidly that it bursts into flame. Place a few drops of glycerin in the center of a small metal dish. Cover completely with finely powdered potassium permanganate, and just wait. Soon the mixture will start to smoke and suddenly flare up with a bright bluish flame.

In aqueous solution, glycerin is oxidized to glyceraldehyde. Hydrogen peroxide is used as the oxidizing agent. Add a crystal of ferrous sulfate, and a few drops of glycerin. The glyceraldehyde upon further oxidation yields 3-hydroxy-2-oxopropanal, 2-oxopropanal, oxalic acid, formic acid, and carbon dioxide.

Oxalic Acid

To 3 cc. of water, add several drops of sulfuric acid and a few crystals of potassium permanganate. To this, add 10 drops of oxalic acid solution. The acid is oxidized to carbon dioxide and water and the permanganate is reduced to a colorless solution of manganese and potassium sulfates.

Ether

Ether is oxidized by chromic acid to form ethyl alcohol, acetic acid and

ethyl acetate. Add a few drops of ether to 3 cc. of the dichromate solution in a test tube. Warm *gently* and shake occasionally. As the ether odor disappears, see if you can recognize the odor of one or more of the oxidation products listed above.

With alkaline potassium permanganate, the chief product obtained is potassium acetate. Proceed exactly as above, using a dilute solution of potassium permanganate made alkaline with sodium hydroxide solution instead of the chromate mixture.

Anthracene

When anthracene is oxidized, the product is *anthraquinone*, an important compound used in the manufacture of dyes. Place a small quantity of anthracene in a test tube with 5 cc. of glacial acetic acid and boil until the compound is entirely dissolved. Mix a small portion of the dichromate solution with an equal quantity of glacial acetic acid and add 10 drops to the anthracene solution. Crude anthraquinone separates out as a greenish-gray precipitate. Pure anthraquinone is a light yellow solid melting at 286°.

Naphthalene

The oxidation product of naphthalene is *a-naphthoquinone*, which is a yellow solid. As with anthracene, the naphthalene is dissolved in boiling acetic acid and the chromate solution added. The *a*-naphthoquinone separates as a greenish precipitate.

Aniline

Aniline is very accommodating to the oxidation reaction. Depending upon the reagents used, the products obtained are nitrobenzene, nitrosobenzene, N-phenylhydroxylamine, benzoquinone, azoxybenzene and azobenzene, phenylquinonediimine, emeraldine, nigraniline, and various aniline blacks. We shall only attempt to obtain a few of these compounds. *Nitrobenzene* is formed with alkaline hypochlorite solution. Place a small quantity of calcium hypochlorite in a dilute solution of sodium carbonate. Stir thoroughly and add a few drops of aniline. Continue stirring until you can recognize the almond-like odor of nitrobenzene.

Along with other products, aniline black is obtained with chromate solution. You will readily recognize the deep black dye when a few drops of aniline are added to the chromate solution. Under controlled conditions, *quinone* can be obtained with the chromate solution. It can also be obtained by oxidizing the aniline with a solution of manganese dioxide in sulfuric acid. Potassium permanganate will oxidize aniline to yield azobenzene and nitrobenzene. In an alkaline medium, the azobenzene is obtained with ammonia. Hypochlorous acid will produce *p*-aminophenol.

Phenol

When phenol is oxidized, the benzene ring is broken and products formed include oxalic acid, meso-tartaric acid, and carbon dioxide.

Dissolve a crystal of phenol in a little water which has been made alkaline with sodium hydroxide. Dilute potassium permanganate solution is then added.

Lactose

Lactose (milk sugar) is oxidized by nitric acid, yielding a mixture of mucic and oxalic acids.

Place one gram of lactose in an evaporating dish and add 5 cc. of con.

nitric acid. Heat gently until the brown fumes appear. Then remove the flame, as the action will proceed of itself quite vigorously. After it quiets down a bit, again apply a gentle heat until the brown fumes are no longer evolved. *(Do not inhale these fumes!)* Add an equal volume of water to the remaining solution and allow to cool. If you care to obtain the products, evaporate the solution by half, allow to crystallize, and treat the crystals with warm alcohol. The oxalic acid will dissolve in the alcohol, and the remaining mucic acid can be recrystallized from boiling water.

Toluene

Toluene is oxidized to benzaldehyde and the latter to benzoic acid. Add finely powdered manganese dioxide to a dilute solution of sulfuric acid. To this, add 10 drops of toluene and shake. See if you can recognize the almond-like odor of benzaldehyde. Alkaline potassium permanganate will carry the oxidation further on to benzoic acid.

So much for oxidation. We have tried to include a wide variety of reactions which are typical of the oxidation procedure. Of course, we have but scratched the surface of this important aspect of organic chemistry, for many hundreds of oxidation reactions are performed constantly to obtain a multitude of useful compounds.

Sugar For Mouse Trap Bait

➤ NEXT TIME you have to bait a mouse trap, try sugar or something sweet. This suggestion comes from research by Dr. Norman Guttman, psychologist at Duke University.

Rodents, or mice and rats to you, have a sweet tooth, he has found. In scientific investigations sponsored by the National Institute of Mental Health, Public Health Service, the Duke psychologist is trying to work out a mathematical theory of the relation of food rewards to animal behavior.

On the basis of experiments he has already made, Dr. Guttman thinks it likely that a rat's taste receptors are about like our own and that it is the taste of a food rather than its nutritional value which immediately causes a rat to seek particular foods.

Scientists know that children motivated merely by the taste of foods will, when left to choose freely, pick out over a period of time foods that make up a well-balanced diet. But they do no know whether or not lower animals tend to do the same.

If so, do nutritional needs affect taste preferences so that food that tastes good is usually good for them? Dr. Guttman hopes his experiments will answer this question.

Here is how the experiments work:

A rat is placed in a sound-proof box containing a lever and a food container. Every time the rat pushes the lever, a bit of food is made available. In these experiments the hunger of a rat is kept under control.

Dr. Guttman's results show that if a rat likes a certain flavored food, the more concentrated the flavor, the faster he pushes the lever to receive a taste. If allowed, he will work all day if he is rewarded at intervals.

Virus Involved in Change Of Normal Cell to Cancer

Cancer Researches Show Progress

➤ TRANSFORMATION of a normal cell to a cancer cell involves the production of a virus, scientists are coming more and more to believe. Fresh evidence for this was presented at the Boston meeting of the American Association for the Advancement of Science. But this does not mean, it was emphasized, that cancer is contagious.

Leukemia, cancerous disease of the blood forming organs, can be induced by a virus filtered from cancerous blood, Dr. Sarah E. Stewart of the U. S. Public Health Service Hospital, Baltimore, reported. This virus can localize not only in blood cells but under some conditions in other cells as well and thereby produce new types of cancer.

Cancer viruses can be changed by their hosts, that is, the bodies in which they live and grow, studies reported by Dr. Kenyon S. Tweedell of the University of Illinois show.

Dr. Tweedell studied a cancer which is common in kidneys of frogs of northern Vermont. These cancers yield a virus which will localize in normal kidneys and transform them to the same kind of cancer. But the virus does not have this effect in frogs from another geographic area. The same species of frogs from New Jersey, Wisconsin, Illinois and Kentucky are never affected by Vermont virus.

In time, however, a Vermont cancer grafted into the eye of a Wisconsin frog, after growing slowly will regress and almost fade away. Then it starts growing again. The new growth has in it a virus trained to induce cancer in kidneys of Wisconsin as well as Vermont frogs. If it fades away a second time and regrows again, it can attack other organs as well as the kidneys.

This host-induced adaptation of a cancer virus gives scientists a little better understanding of the relationships between the host cell and its directors. Apparently under normal conditions these directors, which are within the cell and are probably nucleoprotein chemicals, direct the growth and differentiation of normal tissues. It is now believed that it is only when they become faulty that they direct abnormal growth and differentiation and then are recognized as viruses.

Old Theory Overthrown

➤ A 25-YEAR-OLD cancer theory first proposed by the famous German biochemist and Nobel prize winner, Otto Warburg, has been overthrown by atomic age research reported at the American Association for the Advancement of Science meeting.

The old theory came from Warburg's finding that cancer cells convert sugar to the milk-souring chemical, lactic acid, in much greater amounts than normal cells do. This gave Warburg the idea that cancer cells may have a primitive type of metabolism in which energy is pro-

duced by fermentation. Subsequent studies by other workers promoted this theory.

But the fermentation process is a relatively inefficient energy producer. It yields only three-tenths of a calorie per gram of sugar as compared to six calories per gram when sugar is completely burned to carbon dioxide, or nine calories when fats are burned to carbon dioxide. This would not seem to be enough to supply the energy needed by rapidly growing cancer cells.

In this atomic age, a critical test could be made of the old theory. Fats and sugars could be labelled with radioactive carbon from the U. S. Atomic Energy Commission and fed to cancer cells. This was done in the laboratories of Lankenau Hospital Research Institute, Philadelphia, under the supervision of Dr. Sidney Weinhouse who reported the studies.

The test showed conclusively that cancer cells are able to carry out the complete combustion of sugars and fats to carbon dioxide and that they use the same mechanism as normal cells.

The high lactic acid production of cancer cells compared to normal cells, it is now believed, is due to a difference in amount or distribution within the cancer cell of a potent catalyst known as DPN, short for diphosphopyridine nucleotide.

This substance, which contains as one of its components the vitamin, niacinamide, is present in animal cells in amounts of the order of 50 to 500 millionths of a gram per gram of tissue. It was found that its content in cancer cells is very low as compared with normal tissues.

This work was done by Charles E. Wenner, Ruth H. Millington, Grace Medes, Morris A. Spirtes, Arthur Allen, Alice A. Thomas and Lillian Jedeiken.

Tritium Attack on Cancer

➤ WHETHER or not an H-bomb is ever used as a military weapon, its special kind of hydrogen, called hydrogen-3, or tritium, may be used in an attack on cancer. Steps toward this were reported by Dr. Dietrich E. Beischer of the U. S. School of Naval Aviation, Pensacola, Fla., at a regional meeting of the American Chemical Society in New Orleans.

Tritium, which is now available to researchers in quantity, has an extremely short range of radiation, and it is this property which may make it particularly suited to the selective destruction of cancer cells. Certain chemical compounds are taken up by cancer cells more readily than by healthy cells, and if these compounds are "tagged" with tritium, the short-range rays will reach only the cells which take up the compound, leaving the neighboring cells undamaged.

Dr. Beischer described the development of a new method which detects and measures the dose of radiation emitted inside tritium-tagged tissue. The method, called a radioautographic procedure, consists in clamping the tissue to an X-ray film and thus forcing the radioactive material to take its own picture.

Tritium is especially useful for investigations of biological systems, where hydrogen plays an important part as a constituent. Substitution of the radioactive form of hydrogen in such systems permits simple and ef-

fective radioautographic study of the systems.

Leukemic Children Helped

➤ ALMOST ALL the children who have acute leukemia, malignant disease of the blood and blood-forming organs, can now be given some kind of remission during which they will for a time be restored to health, Dr. C. P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, declares.

This is possible through the use of three groups of modern chemicals: 1. antifolic acid chemicals; 2. cortisone and ACTH, famous first as arthritis remedies; and 3. 6-mercaptopurine.

This last, 6-mercaptopurine, has been distributed to more than 200 groups of cancer fighters since January, 1953. It is not a cure but it has brought remissions to about half the patients treated. It helps both children and grown-ups with acute leukemia and is active in some children who are refractory to antifolic acid chemicals. The remissions have lasted in some patients "for a good many months," but others have relapsed within weeks.

Reports of the patients who have gotten the chemical are now being analyzed, Dr. Rhoads told the American Pharmaceutical Manufacturers' Association meeting recently.

The drug was developed through a joint research program with Wellcome Research Laboratories, Tuckahoe, N. Y., the Southern Research Institute of Birmingham, Ala., and the Sloan-Kettering Institute.

This new chemical is one of many specifically designed to interfere with utilization by cancer cells of materials needed for manufacture of the nucleic acids vital to cell life. It could be made on this rational and specific basis because scientists have discovered in recent years that the nucleic acid, DNA, of cells is not the same for every cell. They can therefore hope to tailor drugs to interfere with DNA production in each of the eight main death-dealing kinds of cancers: lung, breast, uterus, intestines, prostate, bladder, mouth and the leukemias.

Since 6-mercaptopurine is not a cure for leukemia, scientists are now working to design a more specific anti-leukemic cell chemical. Dr. Rhoads feels sure they will succeed, though when and with what change in the 6-mercaptopurine molecule cannot be told.

But following these principles it will be surprising, he said, if scientists do not find new and better means for cancer control in man within the foreseeable future.

Clue to Lawless Cells

➤ CANCER "detectives" at the University of California at Los Angeles have found another clue to the cause of lawless behavior of cancer cells.

Dr. A. M. Schechtman and Arthur Hirata of the zoology department have found that proteins from rat liver cancer cells have a tendency to stay in solution and not form clumps or aggregates as rapidly as those of normal liver cells.

In previous work the U.C.L.A. zoologists had found that cancer cells contain more highly charged proteins than normal ones. Since it is known that higher charged particles tend to keep apart, they suggest that this is the factor that hinders the cancer pro-

teins from forming clumps typical of normal proteins. And thus it may be related to the wild, unregulated behavior of cancer cells.

Just what causes the differences in electrical charges is not known, the investigators say. This is apparently another of the subtle differences between cancer and normal cells.

Such painstaking detective work is accumulating evidence of these differences bit by bit, Dr. Schechtman says. When we find enough of them, we may have the answers that will some day result in the conquest of the disease.

Indian Surgeons Used Anesthetic

➤ SHOWY PLANTS with soft pink and salmony pastel flowers decorating the gardens of the head-hunting Jivaros high in the Andes probably hold the secret of the anesthetic used by ancient surgeons who did skilful trepan operations on the skulls of former inhabitants.

This is the opinion of Dr. W. H. Camp, curator of experimental botany and horticulture in the Academy of Natural Sciences of Philadelphia.

The plants belong to the genus Datura. Stramonium and jimson weed are among the Datura species. The leaves and seeds yield a powerful narcotic and Jivaros today grow the plants and use the leaves for this purpose.

The potency of these leaves is attested by an associate of Dr. Camp's during a plant hunting expedition, Henning Jorgensen. A few years ago while panning for gold in the Oriente, Mr. Jorgensen suffered an accidental gunshot wound of the leg. No doctor was available to remove the bullet. The Jivaros took charge, giving him a decoction of Datura leaves to drink. He soon became drowsy and when he awoke, about 36 hours later, he found the bullet had been removed and the deep wound poulticed.

Unfortunately, he could not see, Dr. Camp relates. He complained about this, but was told to be patient. He said he did not regain normal vision for another four or five days, after which there was no apparent further effect of the narcotic.

Scientists have sometimes said that ancient surgeons had their patients chew cocoa leaves to deaden pain while their skulls were being trepanned for relief of brain abscesses or similar brain afflictions. Dr. Camp thinks the Datura leaf concoction must have been the anesthetic that held the patient still for the tedious and painful operation.

He tells the story of Mr. Jorgensen's experience in Memoirs of the New York Botanical Garden.

"Calico" and "cashmere" are derived from the names of their places of origin, the city of Calcutta and the state of Kashmir, respectively.

Land capabilities are the first thing to be determined in developing a complete, coordinated soil and water irrigation plan for a farm or ranch unit.

Crystal Models Illustrate Hidden Inner Structures

The Crystal State

➤ CRYSTAL STRUCTURE is a property of matter in the solid state. The fact that a substance has crystallized is taken as proof that it is unmixed with dissimilar material.

Crystals result in three ways: when matter in the liquid state cools below its melting point, when the liquid in which a solid substance has been dissolved evaporates away, and when certain substances (such as iodine) change directly to a solid from a gas.

As each atom of the solidifying substance joins those already in place in the solid structure, forces of attraction draw it into the crystal form characteristic of the kind of matter it is.

When crystallization starts a tiny particle of dust falling on the surface may cause some of the solidifying material to crystallize out upon it, and more crystals to build around that nucleus. Sometimes a slight mechanical shock to a supersaturated solution will make the whole of the salt change suddenly to a mass of crystals. Photographers' hypo has this interesting property.

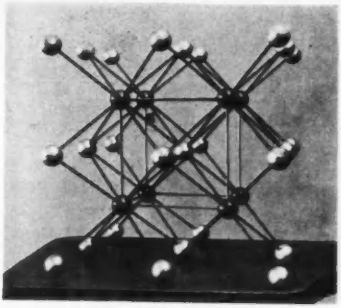
If a few drops of a saturated hypo solution are placed between two glass lantern slides and the beam of light passing through them is focused on the screen, the sudden formation of crystals can be watched. If this light is polarized and an "analyzing" crystal or film is used with it, the structure of the crystal planes appears in brilliant color and adds to the fascination of watching this phenomenon.

It is apparent in watching such crystals form that each crystal spreads out from the center until it runs into some interference either from a foreign substance, such as the walls of the container, or from some other crystal developing nearby. The limits, therefore, of crystal form are thus seen to be closely akin to the geometrical problems of space-filling shapes.

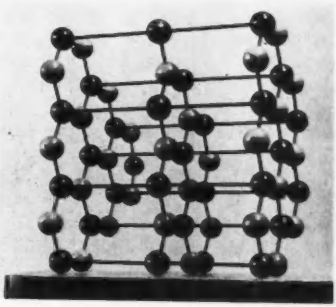
Even non-mathematical persons, after playing with pencil, compass and ruler, or with flooring tiles, or children's blocks, will soon learn that the kinds of symmetrical shapes that will fill a plane with no space left over are very few. Squares will do it. So will hexagons, which may be divided into triangles. So it is not surprising to find these the basic shapes of space-filling crystals.

The interesting thing is to note how layer upon layer of atoms build up into prisms and pyramids, often of complex forms, as though one crystal were growing through another. Some minerals are famous for this kind of double structure which, when perfect, is called "twinning." Staurolite, the well-known "fairy stone" often sold in curio shops, occurs habitually as a perfect cross, with four equal arms at right angles to each other. A rarer form of the same mineral takes the shape of the letter X.

Another type of modification less pronounced than twinning shows corners missing. Sometimes these have



Cesium chloride



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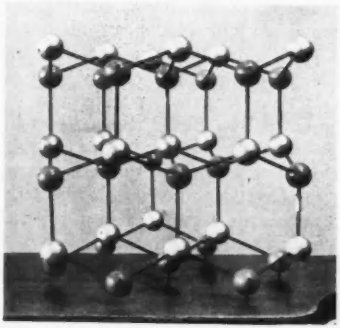
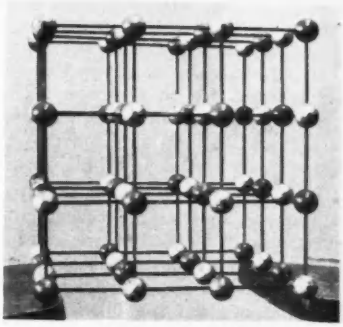
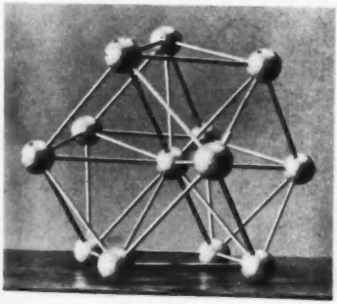


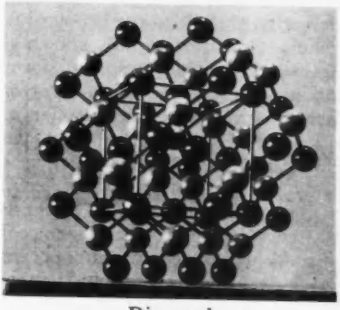
Zinc sulfide (Wurtzite)



Sodium chloride



Magnesium



Diamond

➤ MODELS *of atomic lattices in some of the better known crystals.*

right- and left-hand symmetry. Some crystals will have considerable material missing from the theoretical shape of the figure at opposite corners, as upper left and lower right, while other similar crystals of the same chemical composition will have upper right and lower left corners missing, while the remaining corners, in each case, will much more perfect. They will probably be only slightly blunted.

Crystals with this type of irregularity often occur in organic compounds whose molecules can be arranged in two ways with reference to one of the carbon atoms, the two ways being mirror images of each other. The tartaric acids, studied by Pasteur, are famous for this property. The right-hand arrangement of the formula is linked to the right-hand modification of the crystal, and the opposite.

Blunt-cornered crystals of this type are the ones showing the piezo-electric effect, studied by Pierre Curie and his brother, in which a difference in electric polarity can be shown when the opposite similarly modified corners are squeezed in a vice.

To illustrate the property of piezo-electricity, the salt to use is potassium sodium tartrate, anciently known as Rochelle salt. This compound forms the lop-sided crystals which are necessary to demonstrate the peculiar relationship between the different axes of the structure. The property most easily demonstrated is the electric charge which this crystal acquires when heated to 100° C. and then cooled suddenly, to the temperature of ice. Small bits of paper or pith will be attracted electrostatically, and will cling to certain surfaces of the crystal. These surfaces are the electric poles of the crystal, and are the spots at which an alternating current should be applied to obtain mechanical vibration. If the crystal is squeezed at these points, also, the electric phenomenon will appear.

In a quartz crystal, the optical axis is in line with the points of the pyramids which terminate the prism. But the electrical axis passes through the prism at an angle to this main axis, and its two ends are the two lopped-off corners which give the structure its right-hand or left-hand symmetry.

Models of the way atoms build themselves into regular crystal shapes can be constructed by piling marbles. If a bit of modeling clay is used to stick them together, a cube can be constructed by piling the marbles so that each rests on only one marble below it and touches four in the same layer. Crystals built on this pattern are cubes or square-sided prisms. Common salt (sodium chloride) forms small cubical crystals. Galena (lead sufide) is noted for the large, regular cubes in which it occurs as a mineral. Cubic crystals belong to the class the mineralogists call "isometric."

A different arrangement of units gives another sort of isometric crystal. This is built up the way piles of cannon balls used to be arranged at the base of a war hero's statue. To build it with marbles, place four together to make a square and rest a fifth marble in the center, resting on each of the first four. This arrangement makes a four-sided pyramid. When the design is complete it forms a double pyramid with eight triangular sides or faces. Sometimes a square prism will terminate at each end with such a pyramid.

If many marbles are built up into

these characteristic crystal forms it is soon evident that more marbles can be put into the same space, a box, for instance, if the pyramidal arrangement is followed. In crystallography, as in ordinary speech, this is called the "close-packed" arrangement.

If a ring of six marbles is the starting unit, instead of a square of four, a seventh marble will fit into the center if all are the same size. The pattern can be extended in one plane if each marble is then taken as the center, in turn, and a new ring built around it. This arrangement fills the plane. But when a second layer of marbles is added above the first, there is still the choice of duplicating the first layer, with each marble resting on the corresponding one below it, or, again, a close-packed arrangement with each marble supported by three in the first layer.

Working out patterns with these space-filling arrangements can be a fascinating pastime. It is also a very practical model, for scientists, of the way units of matter too small to be seen can be assumed to be arranged. Theories built on such assumptions have opened the door to much new knowledge of atomic structures.

Mathematical analysis of the possible space-filling structures shows that there are 32 possible classes of crystal symmetry, 14 space-lattices and 7 types of crystal form. These 7 distinct types have been named by mineralogists: triclinic, monoclinic, rhombic, hexagonal, rhombohedral, tetragonal and cubic.

In some of the 14 kinds of space-lattices atoms occupy the corners of the ideal figure, for example, a cube, while another atom occupies the center of the solid figure. Such an arrangement is said to be body-centered. In another type, the fifth atom in the repeat of the pattern is on the surface, at the center of each face. This is the face-centered arrangement.

The planes within the crystal are very important for another measuring job at which crystals are employed in the laboratory. In this job, these planes diffract X-rays which are allowed to pass through the crystal. Although we cannot see with our own eyes objects which are smaller than one-half the wave length of visible light, the shorter X-rays can stretch the limit of visibility because they affect photographic plates, and we can see the pictures that result.

Such pictures are not enlargements of things too small to be seen. They are fuzzy shadowgraphs showing spots in varying arrangements. They result from three-dimensional interference among the light-waves which go through the crystal. But physicists can project the lines backward through a model of the crystal and calculate the structures against which the X-rays bounced. Thus, indirectly, we can get down quite close to objects of atomic size. Relative positions of atoms in crystals and the angles between them are known with considerable accuracy, and even the relative diameters of the atoms have been determined.

Crystals of chemical salts, especially of the series of sulfates known as the alums, are easy to grow and make a spectacular showing. The method is simple, although skill and patience are required to produce really large crystals. Common salt will do as an example to show the method. Rock

salt can be used with perhaps the best results. Table salt usually has other salts mixed with it to avoid its habit of drawing moisture from the air, and to add iodine to the diet. Dissolve the salt in as little hot water as you can, in a dish which will allow both depth of solution (to produce a large crystal) and surface (for evaporation of the solvent). A glass cup designed for baking custards will do very well.

The solution should be saturated. It should contain all the salt it will hold, but there should not be much undissolved salt on the bottom of the dish. Let it cool very slowly in a place where it will not be jolted. Setting the dish in a box which has cloth bunched into it will protect the bottom of the dish from cooling too fast.

The top of the dish should be protected against dust falling into the solution, yet should not be so well covered that evaporation is hindered too much. A sheet of filter paper or a layer of cheese-cloth over the top will be enough. A lid should be avoided, because the liquid will condense on it and drop back into the solution. This makes too much disturbance for the formation of large crystals.

After setting the solution to crystallize, as described, let it alone for at least a day. When you go back to look at it, you may find no crystals at all, you may find a ring of salt around the top of the liquid, or you may find a number of small but distinctly shaped crystals at the bottom of the dish.

If there are no crystals, you may have started with too dilute a solution. Heating the liquid until steam comes off, but before active boiling starts, and returning the dish to its insulated box for another 24 hours will probably start crystallization. If you like, you can "seed" this solution by dropping into it a single well-formed crystal saved from the original stock.

If the crystals "creep" up the sides of the dish, put a little petroleum jelly on your finger and wipe it around the inside of the dish above the surface of the liquid. The solution will stay below this line.

If you want to try suspending a crystal in the middle of the solution, a fine wire or a hair may be used to make a supporting loop. This may be hung from a pencil laid across the top of the dish. Keep the crystal submerged.

Salts which are easily obtained from laboratory supply houses which will give examples of the seven types of crystal forms are as follows—

1. *Cubic*—Sodium chloride ($NaCl$), table salt or rock salt, white; and *Octahedral* — Chrome alum ($KCr(SO_4)_2 \cdot 12\,H_2O$), chromium potassium sulfate, red or green; 2. *Rhombic* —Calcium sulfate ($CaSO_4$), white; 3. *Rhombohedral* or *trigonal*—Cobalt chloride ($CoCl_2$), blue; 4. *Tetragonal* —red lead (PbO) lead oxide, orange-red; 5. *Hexagonal*—ammonium alum ($NH_4Al(SO_4)_2$), aluminum ammonium sulfate, white; 6. *Monoclinic*—manganese sulfate ($MnSO_4 \cdot 4H_2O$), pink; 7. *Triclinic* — copper sulfate ($CuSO_4 \cdot 5H_2O$), blue.

The tung tree, source of tung oil for paints, was introduced into Florida about 25 years ago but American tung growing now centers in coastal areas of Mississippi and Louisiana.

Chemical Recovery Uses Gentle Methods

Vulcan's Assistants

Reprinted from Industrial Bulletin *of Arthur D. Little, Inc.*

➤ FIRE has been and is the chief means for winning metals from their ores, but water and other gentle agents are the main interests of today's research workers. The objectives now are not development of new, rich, ore bodies —for there are few of these—but ways of extracting metals from hitherto unworkable deposits, wringing more values from discarded mine tailings, and producing metals entirely new to commerce. To do these jobs, many of the subtle techniques of the chemical industry are being used, and still more are in the research stage.

Chemical recovery methods are not new. Copper has long been leached from crushed ore and then thrown out of solution with iron. One astute metallurgist amassed a large fortune in the early days of Western copper mining by precipitating pure copper from water crossing his property after flowing through someone else's mine. Gold and silver have been dissolved from the ore with cyanide and precipitated with aluminum or zinc. Electrolytic processes yield the purest commercial copper, silver, and gold, and are also used for commercial production of zinc, lead, cadmium, nickel, tin, manganese, and other metals.

Ammonia was used during World War II at the Nicaro plant in Cuba to leach nickel from ore, when it could not be extracted by the usual methods. This plant was recently reactivated because of the pressing need for nickel in jet engines, new automotive alloys, and many other uses. Similar techniques have been proposed for low-grade zinc ores. Ammonia leaching under pressure will be used for nickel-cobalt ores in a new refinery in Alberta; acid leaching will be used for cobalt in another new plant in Utah. In both plants, hydrogen under high pressure will be used to precipitate the metal from solution. There are difficulties in translating this process from bench-scale experiments directly to the commercial stage, but development is continuing.

Ion exchange, common as a metal-removing method in water-softening systems, is used as one step in recovery of uranium from a South African gold ore. In such systems, a resinous material preferentially adsorbs ions of the wanted metal. Rare-earth metals, difficult to separate because of their close chemical similarity, were produced in usable quantities for the first time with ion-exchange resins. The technique has been proposed for separation of various combinations of naturally-occurring metals. In the future, ion exchange may be used to concentrate metals as a feed for electrolytic or other chemical separation processes.

A new process, called chelation, used in chemical analysis, shows promise of commercial application to separation of unusual metals. A chelating agent is an organic chemical capable of seizing a metal atom and holding it fast. Metal ions are "seques-

tered" within the chelate, removed from the original solution, and later separated as the pure metal.

Radioisotopes, widely used in research, have been suggested as aids to metal production. One possible use is in separating beryl from its ore on the basis of an induced radioactivity, rather than hand sorting based on color. If beryl-containing ore is fed in a thin stream past a source of gamma radiation, the ore begins to emit neutrons. These neutrons can activate an electronic-mechanical circuit to kick the beryl lump aside.

Some metal salts can be dissolved in synthetic organic solvents; refining processes based on their different solubilities are now being worked out. More in the "blue sky" area of research is the use of biological concentration. Many plants or microorganisms concentrate metals in their tissues. Vetch, for instance, accumulates selenium, and the affinity of spinach for iron is well known. Many microorganisms also aid in leaching metals. Research projects on the deliberate, controlled use of living organisms are under way.

Prospectors Should Study Geology

➤ Look for uranium only in certain areas of the world and in certain kinds of rock formations if you wish to find rich deposits of the ore.

Time spent poking a Geiger counter into all kinds of geological formations is wasted, according to Donald L. Everhart, geologist of the division of raw materials, Atomic Energy Commission. He described to members of the New York Academy of Sciences the classification of uranium deposits worked out as a result of the stepped-up search now going on.

Locations of the richest uranium deposits are the hydrothermal veins in western Europe, western and central Africa, along the western margins of the Canadian Shield and along the entire length of the Cordillera of North and South America, said Dr. Everhart. The widespread distribution of small quantities of uranium in other localities occurs because uranium compounds dissolve in many kinds of ground water and combine with carbonaceous material. Geologically, uranium behaves much like iron.

Next to the rich vein deposits, the best place to look for the radioactive mineral is along old stream beds. Here geologists are divided in opinion as to whether the uranium compounds were deposited in the clay as it silted out of the running water or whether they welled up from deeper waters and were added to the clays from below.

Three time epochs seem to have contributed the richest store of uranium to the rocks where it is now mined. The oldest uranium-bearing rocks are contemporary with the very dawn of life on this planet, at the end of the Pre-Cambrian era. A second time of deposition of uranium ore was when the giant reptiles left the swamps and moved to dry land, at the end of the Paleozoic age. Again at the end of the age of reptiles, when man's earliest four-footed ancestors appeared, uranium was deposited in early Tertiary rocks. What connection there is geologists have not yet worked out.

Mysterious Analogues of Manganese, Halogen Family Share Group VII

Analyzing For All the Elements

Group VII a and b

▶ MANGANESE has been known for nearly two hundred years. During that time relationships between all the elements have been worked out. At first similarities caused certain elements to be grouped into sets of three. Finally the dissimilarities between elements when ranged in order of atomic weight were seen to vary from one element to the next in periodic fashion. But manganese was always a puzzle.

Some elements were observed to form "triads," like chlorine, bromine and iodine, or lithium, sodium and potassium, or copper, silver and gold. Manganese seemed no more strange than many of the new elements that had been discovered. But it had no analogues in the periodic table.

This mystery led to the general question, of great interest to present day scientists, as to why certain elements are extremely scarce while others occur in great abundance. Now a clue to how the elements were formed in the first place has been glimpsed, through studies of atomic transmutations.

Elements are known to have nuclei made up of closely packed protons and neutrons. These entities are not jumbled together but arranged in space by their mutual attracting and repelling forces. Certain configurations of both protons and neutrons are apparently more stable than others. Elements with such stable nuclei are found abundantly on earth and throughout space, wherever spectroscopic records from distant heavenly bodies can be obtained.

Based on results of such surveys, combining counts made by astronomers on distribution of elements in the stars and analyses by geologists of minerals of the earth's crust, manganese is approximately the 20th element in abundance.

In 1925 the German chemists, Dr. Noddack and Fraulein Tacke, decided to search in the most promising ores for traces of the manganese analogues, being persuaded that the reason they had not been discovered must be because they exist in very small quantities. The chemists were successful in finding very small traces of element 75, which they named Rhenium.

Element 43 was not found until it was made artificially by transmutation of molybdenum. Because it was made by technical processes, it was given the name technetium. Although efforts to find this element on earth have failed, its spectrum is found in certain stars.

Methods used for detecting the analogues of manganese are quite different from the standard reactions

of the qualitative analysis scheme. But the kinds of compounds formed by related elements have a certain theoretical interest. The three metals of Group VII. are described here from both viewpoints.

Manganes

Manganese sulfide is one of the compounds precipitated by ammonium hydroxide and ammonium sulfide. The precipitate is dissolved in acid, oxidized, and the manganese is precipitated as manganese dioxide. This compound, it is interesting to note, is insoluble in sea water. Objects dredged up from the bottom of the ocean are frequently found coated with it.

Technetium

The sulfide of technetium is precipitated by hydrogen sulfide from acid solution. When the strength of the acid is increased, less technetium sulfide and more rhenium sulfide is precipitated. When precipitation is made with hydrogen sulfide from alkaline ammonia solution, technetium sulfide precipitates with manganese.

For actual determination of technetium, its radioactivity is identified and counted with a Geiger counter or similar device.

Rhenium

Rhenium sulfide seems to be precipitated from acid rather than from alkaline solutions. For analytical work, however, the element is extracted from acid solution with potassium thiocyanate and amyl alcohol. Quantitative estimation is made by measuring the depth of the yellow color of this solution with special apparatus.

The Halogens

The group of five elements know by this name contains the most negative elements, which are among the most active chemically.

Fluorine, the lighest member of the set, is a gas which combines with so many commonly inert materials that it is very difficult to handle. Precipitation as lead chlorofluoride is a standard method of determining fluorine by weight.

Chlorine is familiar in combination as the typical salt-former. The element is a heavy gas. Although less violent in its reactions than fluorine, it is very reactive, and is never found uncombined in nature. Precipitation of chlorides with silver nitrate is the classic method for both qualitative and quantitative analysis, if chlorine is the only halogen present. Silver bromide and silver iodide will also form in this reaction, if those halogens are present. For some purposes, the precipitate with silver, reported as "total halides" is sufficient.

Bromine is a rare element, whose most common source is in the salts of sea water. Bromine is a liquid at ordinary temperatures when prepared in elemental form. It is soluble in organic solvents, and may be separated from a water solution by shaking with carbon tetrachloride.

Iodine, obtained from sea weed, in which it has become concentrated, is a crystalline solid which has properties bordering on the metallic. Iodine, like bromine, is soluble in organic solvents. The "tincture of iodine," familiar as a local antiseptic, is a solution of the element in alcohol. A char-

acteristic test for iodine is the blue color formed when it reacts with starch.

The properties of the halogen family of elements show an interesting gradation from gaseous to solid, and from non-metal to metallic, as the elements increase in atomic weight.

Astatine is the newest, heaviest and rarest of the halogens. It is one of the elements absent from the earth but created by transmutation in the atomic pile. Very little of the material has ever been made. The properties identified for the small amounts that have been studied mark this heaviest member of the halogen group as truly metallic in form. It is, of course, radioactive, and is usually identified by its characteristic rate of decay.

Group VII. Elements in Test Reactions

	HCl	H_2S	$(NH_4)_2S$	$(NH_4)_2CO_3$	Special Test
VII.a.					
Mn	—	—	MnS	—	Purple color with sodium bismuthate.
Tc	—	—	TcS	—	Radiation data.
Re	—	ReS	—	—	Rhenium thiocyanate gives yellow color to amyl alcohol.
VII.b.					
F	—	—	—	—	Prec. as lead chlorofluoride.
Cl	—	—	—	—	Prec. with $AgNO_3$.
Br	—	—	—	—	Oxidize with permanganate, extract with CCl_4.
I	—	—	—	—	Blue color with starch.
At	—	—	—	—	Radiation data.

On the Back Cover

➤ A CRYSTAL *of pure aluminum has the shape and structure shown by this crystal model, apparently formed of pairs of interlocking pyramids. The crystalline form of aluminum has been worked out within about the past quarter century, as the structure of metals and alloys has become better understood.*

Chemical Methods Used To Improve Common Things

Chemical Treatments in New Patents

Copies of patents may be obtained directly from the Commissioner of Patents, Washington 25, D. C. for twenty-five cents each. Order by number and enclose coins, money order or Patent Office coupon. Do not send stamps.

Watch Crystal Treatment

➤ UNBREAKABLE watch crystals can be made clearer and more durable by a quick heat treatment worked out by Paul Halbig and Carlo Taddei of Fribourg, Switzerland.

After the crystal is forced into its frame, the surface often is slightly scarred or has become flawed. By heating the "ouside" surface rapidly while chilling the "inside" surface, these flaws can be eliminated. The crystal becomes more transparent and more resistant to the deteriorating effects of perspiration and some watch bands. The method is protected by patent No. 2,659,105.

Shotgun Pollination

➤ IF YOU are driving through Wapato, Wash., next spring and see a farmer blazing away with his shotgun at blossoms on his fruit trees, you probably will be witnessing Louis J. Farley as he tests his new method of tree pollination.

According to the two patents he has received, pollen is packed into a shotgun shell having about half the powder charge of ordinary shotgun shells. To prevent over-pollination of the blossoms, the pollen is mixed with a "distributing" medium such as powdered skim milk.

When the gun is fired at the blossoms, some of the pollen makes direct hit upon the blossoms to be fertilized. The rest of the powder settles through the tree onto other blossoms, Mr. Farley states. Mr. Farley's invention is protected by patents Nos. 2,660,002 and 2,660,003.

Weed Destroyer

➤ A CANE-RESEMBLING device has been invented to aid the home gardener selectively destroy weeds with chemicals where hand-weeding now must be employed.

A conventional culture tube containing toxic fluid is attached to the end of a waist-high handle. The culture tube delivers its weed-killing solution to a brush on the very tip of the device.

The invention permits the user to destroy individual weeds in flower beds or in gardens. At present, it sometimes is dangerous to use weed-killing sprays in these spots because of the susceptibility of flowers and vegetables to the weed-killer solutions.

The device was invented by Lewis D. Stoner of Oakland, Calif., who assigned his patent, No. 2,659,918, to the Alston Manufacturing Co. of Oakland.

Home Air Conditioning

➤ A RESIDENTIAL air conditioning system, particularly suitable for ranch-type houses, has been invented to skirt around disadvantages presented by

water cooling towers in residential areas.

Designed by Charles Mason Gerhart Jr. of York, Pa., the system uses the house roof and its gutters to cool by evaporation water leaving the refrigerating plant inside. The water is pumped into a porous hose along the roof ridge. It trickles through the hose and runs down the roof into the gutter which channels it back into the refrigerating system.

In addition to equipment economy, the system also has these advantages, the inventor points out: Continuous cooling of the roof which reduces the "sun load"; a prolonging of the life of a composition roof which deteriorates faster when hot and dry than when cool and wet. No spray is created by the hose to be wafted about on windy days.

Mr. Gerhart assigned his patent, No. 2,660,863, to the York Corporation, also of York, Pa.

Storage of Biologicals

➤ HOWARD O. MCMAHON of Lexington, Mass., has found a way of storing biological materials that otherwise spoil quickly.

In his patent, No. 2,662,520, Mr. McMahon points out that vaccines, sera, enzymes, hormones, and various living biological materials such as molds, bacteria and tissues for transplanting, have short storage life unless the temperature is held low.

But at freezing temperatures, water crystallizes in the cellular structures of some of these materials. This often damages the biologicals severely.

His device permits the storage temperature to be shoved down to about four degrees below zero Fahrenheit, without freezing the biologicals. This is accomplished by canning the material under a pressure of 2,000 atmospheres before the temperature is lowered.

He suggests a particularly simple way of doing this. The biological is sealed in a water-tight plastic bag which is lowered into a small tank of water. A lid is bolted on the rigid container and the temperature then is reduced. The water expands as it freezes. This applies pressures up to 2,000 atmospheres on the biological in the plastic bag, preventing it from freezing. Mr. McMahon assigned his patent to Arthur D. Little, Inc., of Cambridge, Mass.

Life Preserver Material

➤ A MATERIAL for life preservers has been patented which is said to be more satisfactory than cork or kapok where rough treatment, humidity and long periods of use and disuse are "normal operating conditions."

The material is a matting of glass fibers from .00003 to .00015 inch in diameter. The fibers are treated to make them non-water wettable which, in turn, makes it difficult for water to penetrate the millions of tiny air spaces in the matting. Invented by Lawrence P. Biefeld of Newark, Ohio, the patent, No. 2,660,736, was assigned to Owens-Corning Fiberglas Corp.

To Increase Jet Range

➤ A NEW TYPE fuel system which will increase the flying range of jets and rockets powered with ram jet engines has recently been patented.

Ram jet engines are efficient at high speeds and altitudes except for poor fuel economy which means a short flying range. Nathan C. Price of Los Angeles, Calif., has designed a fuel

pump system which will maintain a constant fuel-air ratio during flight at varying speeds and altitudes.

Air rushing in the intake part of the craft turns a small turbine connected to a fuel pump. This pump keeps the air-fuel ratio constant, increasing the fuel economy. The patent, No. 2,663,140, was assigned to the Lockheed Aircraft Corporation, Lockheed, Calif.

Plywood From Wood Waste

➤ CLARENCE U. GRAMELSPACHER of Jasper, Ind., has patented a method of making plywood from wood waste such as sawdust and the trimmings from ordinary plywood manufacture.

The rough edges trimmed off regular sheets of plywood are laid with the smooth sides out and the core spaces filled with wood waste like sawdust impregnated with a binding element. The resulting board may be covered with a sheet of veneer if desired. The method received patent No. 2,663,661.

Safer Airplanes

➤ JOHN A. LAWLER of Seattle, Wash., received patent No. 2,664,171 for his invention of a machine to produce nitrogen gas to be pumped into aircraft fuel tanks and body cavities.

Nitrogen is an inert, non-explosive gas and its presence in the vapor spaces of fuel tanks materially reduces the danger of explosion.

Mr. Lawler's machine uses hot compressed air from the plane's engines and a cobalt-chelate compound which removes the oxygen from this air, leaving mostly nitrogen. Before entering the compound, the hot air is cooled by cold air from the outside.

The machine has two units and while one is producing nitrogen the other unit may be reversed to release the oxygen taken from the air for use by persons inside the plane. This patent was assigned to the Boeing Airplane Company, Seattle, Wash.

Automatic Hypodermic

➤ GERALD O. TRANSUE of Havertown, Pa., has invented an automatic injector for hypodermic needles. His device makes it possible for a non-medical person to give a hypodermic injection to himself or someone else rapidly and with a minimum of discomfort.

The hypodermic syringe is inserted into a cartridge which has a spring and cocking mechanism. When the mechanism is released the needle is plunged quickly into the body to the depth desired. This invention received patent No. 2,664,086.

Floor on Sponge Rubber

➤ A SECTIONAL floor insulated with sponge rubber that can be laid directly on frozen ground or ice has been invented by Albert Dietrich of New York. His invention was assigned to the U. S. Army.

The floor sections have tongues and grooves and are clamped together with cam fasteners that can be turned when the person assembling the floor is wearing heavy gloves.

Back of each floor section is a thick layer of an insulating material like sponge rubber. This material not only insulates but eliminates the necessity of having the ground smooth before the floor is put down. Synthetics with similar qualities may be used.

Some sections are furnished with steel flanges to which exterior and interior walls may be fastened. The invention was assigned patent No. 2,663,915.

Book Condensations

MAIN CURRENTS OF SCIENTIFIC THOUGHT: A History of the Sciences — S. F. Mason — *Schuman,* 520 p., $5.00. Science, born of two traditions, philosophical and artisan, produced results that influence its sources and, ultimately, domains far removed from either. It is with these influences that this book by an English author is concerned.

ORGANIC CHEMISTRY: A Brief Course — *McGraw-Hill,* 278 p., $4.00. A textbook to serve the student for whom organic chemistry is a cultural tool rather than professional preparation.

CHEMISTRY FOR OUR TIMES—Elbert C. Weaver and Laurence S. Foster — *McGraw-Hill,* 2nd ed., 666 p., illus., $4.12. Acquainting young people with many of the practical applications of the science.

THE ACTINIDE ELEMENTS — Glenn T. Seaborg and Joseph J. Katz, Eds. — *McGraw-Hill,* 870 p., illus., $11.75. A group of nuclear scientists present the chemistry of all the elements from actinium to the newly discovered trans-plutonium elements.

CATIONIC POLYMERISATION AND RELATED COMPLEXES — P. H. Plesch, Ed. — *Academic Press,* 166 p., illus., $4.00. The conference reported here was devoted to the ease of formation and stability of organic ions.

LABORATORY PRACTICE OF ORGANIC CHEMISTRY — G. Ross Robertson — *Macmillan,* 3d ed., 377 p., illus., $4.00. This new edition features a more extensive treatment of the principles underlying laboratory manipulations.

AN AMERICAN IN EUROPE: The Life of Benjamin Thompson, Count Rumford — Egon Larsen — *Philosophical Library,* 224 p., illus., $4.75. The fascinating life of a scientist with varied talents who is famous not only for the determination of the mechanical equivalent of heat but for a method of brewing good coffee, the development of the Baldwin apple, and the introduction of a kitchen range.

METHODS FOR EMISSION SPECTROCHEMICAL ANALYSIS — ASTM Committee E — 2 on Emission Spectroscopy — *American Society for Testing Materials,* 309 p., illus., paper $4.50, cloth $5.15. The first extensive compilation on emission spectrochemical methods presenting the pertinent information to permit its application in various laboratories.

HIGH ALTITUDE ROCKET RESEARCH — Homer E. Newell, Jr. — *Academic Press,* 298 p., illus., $7.50. This work by the head, Rocket-Sonde Research Branch of the Naval Research Laboratory, is concerned not so much with space travel as with the use of this modern device to study the upper atmosphere, the ozone layer, the ionosphere and cosmic rays.

INDUSTRIAL FERMENTATIONS: Volume I — Leland A. Underkofler and Richard J. Hickey — *Chemical Publishing Company,* 565 p., illus., $12.00. Fermentations are among the oldest chemical processes used by mankind, but it is only in the present century that they have been put on a scientific basis. This symposium presents an authoritative review of recent advances.

Proudly Presented

➤ THE SCIENTIFIC Apparatus Makers Association, which calls itself Sama, has issued a valuable directory of its members. Listed by name, the companies are grouped by sections: industrial instruments; laboratory apparatus; laboratory equipment; nautical, aeronautical and military instruments; optical; and recorder-controller. The two-column format would lend itself to clipping and pasting onto file cards. Each entry gives the company's name, address, telephone number, date of founding, principal officers, and a brief list of its products. Offices of the association are: Chicago 6, Ill., 20 N. Wacker Drive; Washington 6, D. C., 839 17th St. N.W.; New York 18, N. Y., 522 Fifth Ave.

➤ SINCE ZEIN became commercially available in 1944, interest has been increasing in this alcohol-soluble protein from corn, with its everwidening industrial uses. There are 942 citations on these uses in the publication *Zein: An Annotated Bibliography 1891-1953* by Dorothy M. Rathmann, published by Mellon Institute. A copy may be obtained free on request to the publisher at 4400 Fifth Ave., Pittsburgh 13, Pa.

➤ PAPER CHROMATOGRAPHY of Some Alkoxy Acids is the title of a useful article by John H. Nair, III, distributed free by Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa.

➤ TALLOL INVESTIGATIONS, a bulletin of the Engineering Experiment Station, Virginia Polytechnic Institute, Blacksburg, Va., reports studies of a material once considered worthless, for which uses are now being found. Order direct from the Institute, enclosing 25 cents.

➤ NEW LABORATORIES for research on fertilizers, insecticides, fumigants, fungicides, herbicides and related chemicals have just been opened by American Cyanamid Co. in Stamford, Conn.

➤ ATLAS Powder Co., Wilmington, Del., devotes its current issue of "Chemmuniqué" to listing the resins, humectants, emulsifiers, rust inhibitors and enamels it assembled for the Chem Show in Philadelphia.

➤ "PHYSICAL Properties of Synthetic Organic Chemicals" is the title of the annual list put out by Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y. The new issue lists more than 330 products and features 36 new chemicals. Listings are by classes, as Ketones, Ethers and Oxides, Glycol-ethers, etc.

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